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ABSTRACT

To evaluate the accuracy of the 1970 census' occupational classification system, a comparison was made between that year's responses to census questions and the replies by the same population group to the 1972 Postcensal Manpower Survey (PMS). Each of these questionnaires relied on a different methodology; in the PMS the respondent classified himself directly while in the census a clerical coder translated the individual's response into an occupation category. The study sample consisting of 34,936 participants was chosen from the engineering, scientific, and technical fields. Mismatches were found in 19,620 cases, and were ascribed to the following causes: coding or processing errors, structural or methodological differences, and insufficient or conflicting answers. Recommendations made to improve the census classification system included the following: (1) coders should read all the answers in the occupational section before making an assignment; (2) use of the lowest-code rule should be examined; (3) certain occupational titles need to be more clearly defined; (4) responses indicating dual occupations should be placed in a residual category, not assigned to one of the two fields; and (5) more occupational titles should be added to the list. Three recommendations for PMS were proposed: the present categorization of university or college teachers of engineering or science should be changed, examples of appropriate occupational titles should be given for each PMS category, and an investigation should be made into respondents' use of residual categories. (ELG)

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AN EVALUATION OF 1970 CENSUS OCCUPATIONAL CLASSIFICATION

The Postcensal Manpower Survey—Census Match Study

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AN EVALUATION OF 1970 CENSUS OCCUPATIONAL CLASSIFICATION

The Postcensal Manpower Survey—Census Match Study

Issued February 1978

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An Evaluation of 1970 Census Occupational Classification
The Postcensal Manpower Survey—Census Match Study

INTRODUCTION

The Bureau of the Census is continually involved in efforts to evaluate and improve its occupational classification system. The 1972 Postcensal Manpower Survey (PMS), conducted by the Bureau under the sponsorship of the National Science Foundation, enabled the Bureau to make a significant contribution to this ongoing effort. This report presents the methodology and substantive results of a study, known as the PMS-Census Match, that attempted to take advantage of this opportunity.

The sample for the 1972 PMS was chosen from among persons who had been identified in the 1970 Census of Population as being in selected engineering, scientific, and technical occupations in the 1970 experienced civilian labor force (ECLF). Each person had been clerically coded to a detailed 1970 census occupational category on the basis of replies to a set of questions about "current or most recent job activity." In the 1972 survey, these persons were asked to respond to a similar set of questions about their 1970 job. Each person, however, was also requested to select the most appropriate detailed occupational category for this job. In this way, two classifications of the respondent according to occupation in 1970 were made available. It was possible to compare the person's census and PMS categories, and to use the comparison to judge whether the person had been correctly classified in the census.

A person's PMS classification, of course, either agreed or disagreed with the census classification. When it agreed, increased confidence could be placed in the belief that the census had coded the person into an occupational category that accurately reflected the kind of work he or she was doing. When, however, it disagreed, a doubt arose about the validity of the census classification. This doubt would remain until the reason for the difference could be established. It was assumed that one possible cause of disagreement could arise when the person's occupation was described in the PMS differently from the way it was described in response to the census questions. Further research on such cases would reveal whether the census response or the PMS response had provided a more accurate identification of the person's occupation in 1970, or whether the descriptions were in conflict to such a degree that the more appropriate identification could not be determined. Also, it could be that the census and PMS descriptions were essentially the same, but differences in the way the descriptions were collected or categorized had led to the occupational classification differences.

SUMMARY OF OBSERVATIONS

Certain strengths and weaknesses of the census occupational classification system were revealed when it was placed against the background of the PMS system. Additionally, placing the census against the PMS procedure was tantamount to contrasting two different methods of classifying occupations: the census method, in which clerical coders translated responses into occupational categories; and the PMS method, in which the classification was done by the respondents themselves. This contrast was especially important for its insights into the pitfalls of the PMS approach and the ways such pitfalls might be avoided.

In particular, the following observations, concerned with specific means of improving the Census and the PMS occupational classification systems, were made during the study. Their meaning will become clear to the reader once further sections of this report are read. The first six observations are related to the census system; the last three, to the PMS system.

Observation 1. It should be stressed to the census coders that information in all sections of the census occupational question should be considered before they assign an occupational code. Frequently, the coders placed a respondent in an occupation based solely on the written entry in question 34a (See illustration A); this practice led to misclassification errors, especially when the respondent supplied insufficient information in question 34a. Thus, any proposal to reinstate the "cascade rule," (see page 9) or any variation of it, should not be approved.

Observation 2. An extensive examination should be conducted concerning the use of the lowest-code rule (see page 9) in assigning occupational codes to respondents whose jobs involve both managerial activities and activities related to specific occupations such as electrical engineering. Because of the lowest-code rule, the respondents were arbitrarily assigned to particular scientific or engineering occupations, rather than to managerial occupations. A better approach may be the use of the job title section (question 34c of illustration A) as the deciding factor. A respondent who enters a job title that is consistent with the managerial activities reported in question 34b should be classified into a managerial occupation. Otherwise, the person should be coded to a specific scientific or engineering occupation.

Observation 3. Extensive research needs to be done on the major occupational group, "operations and system researchers and analysts," since a significant number of persons are improperly classified into this group. The major cause of the problem is the failure of respondents to differentiate among the various kinds of systems analysts, such as "business" systems analyst or "computer" systems analyst. One partial solution may be the use of industry requirements. For example, a respondent could be classified as a computer systems analyst if the written entry (or entries) is "systems analyst" and the industry code is either 189 ("manufacturing, electronic com-

puting equipment") or 739 ("computer programming services"). Another possible solution is to classify "systems analyst, not specified" under the occupation "computer systems analyst"; of course, doing so could mean that some persons who legitimately belong to the group "operations and systems researchers and analysts" would be misclassified.

Observation 4. A further examination should be made of certain occupational titles that were identified as problem areas. The following are some examples:

a. There does not seem to be any real difference between the title "mathematical actuary" (now included under "036 mathematicians") and the title "actuary" (now included under "035 actuaries").

b. "Psychiatric social worker" should be an occupational title under "psychologists" rather than under "social workers." Many psychiatric social workers coded themselves to the occupation "psychologists" on the PMS. Also, many reported on the PMS that their major field of study was psychology.

c. Some of the occupational titles, such as "wildlife biologist," "fishery biologist," and "plant pathologist," could be moved from the occupation "agricultural scientists" to "biological scientists." This change may make the titles under both of these census occupations more homogeneous.

d. The job title "financial analyst" might be placed more appropriately under the occupation "accountants" than under "economists." The PMS indicates that most financial analysts identified themselves as "accountants" rather than as "economists." Furthermore, most of these persons reported in the PMS that their major field of study was accounting.

Observation 5. The respondent who reports a dual occupation in every part of question 34 should be placed into a residual category rather than into either of the specific occupations. For example, the entry "programmer-analyst" should be coded to "005 computer specialists, not elsewhere classified," instead of to "003 computer programmers" or to "004 computer systems analysts." An occupational title "programmer-analyst" should be added to the list of titles for the occupation "computer specialists, not elsewhere classified."

Observation 6. Some occupational titles should be added to the census classification scheme. "Marketing representative," "microscope operator," and "behavioral science teacher" are additions that should be made.

Observation 7. Most PMS coding errors involve college and university teachers of engineering and science who failed to code themselves to their specific fields of engineering or science as instructed on PMS List C (See appendix A). Instead, these persons placed themselves into the occupational category "451 teachers, college and university, excluding engineering and science." A possible solution would be to underscore the instruction "including college professors and instructors" which is stated on List C after each of the major engineering and scientific occupational groups. Another suggested solution is to change the present code 451 category to read "Nonscience and nonengineering college and university teachers (Engineering and science teachers, see codes 401-432 above)."

Observation 8. A substantial proportion of the mismatches occur because of structural differences between the census and PMS classification schemes. The limited size of the PMS occupational coding list is probably the major reason. As explained in a later section, the PMS classification scheme did not provide the respondents with the occupational titles, such as "financial analyst," included under the List C categories, whereas the census did provide these titles to the census coders. Thus, respondents often misclassified their occupational titles in the PMS. One possible way to minimize these PMS misclassifications would be to add some examples of the appropriate occupational titles to each of the PMS occupational categories. For example, the occupational titles, "botanist," "entomologist," "bacteriologist," could be listed next to the PMS occupational category "biological scientists." This listing would be especially helpful to respondents who are trying to determine whether they belong in one of the residual categories of List C, such as "other social scientists."

Observation 9. Many respondents incorrectly used PMS residual categories (codes 412, 416, 428, and 432) when their occupational titles were included under specific PMS occupational categories. It is hoped that the suggestion made in observation 8 will prevent some of these misclassifications. It may, however, be advisable during the processing stage of future PMS surveys to verify clerically a sample of cases in which the respondents use residual categories. This verification would give the analyst some data concerning the reliability of the counts in these residual groups.

BACKGROUND OF THE STUDY

The official title of the 1972 Postcensal Manpower Survey (PMS) is the "1972 Professional, Technical, and Scientific Manpower Survey." The survey was conducted by the Bureau of the Census during the spring and summer of 1972.[1] The sample for the survey was chosen from among persons enumerated on either a 15- or 5-percent sample questionnaire in the 1970 census.[2] The sample included approximately 97,000 persons who had been classified by the 1970 census as being in the 1970 experienced civilian labor force (ECLF) in one of 64 target occupations. This study is restricted to those members of the sample who were in one of 44 engineering and science occupations and who reported their 1970 occupation in the 1972 PMS; there were approximately 35,000 such persons.

The occupational classifications in the 1970 census are based upon responses to items 33, 34, and 35 on the 1970 census questionnaire. These questions are reproduced in illustration A.

[1] For detailed information on the survey, see U.S. Bureau of the Census, **Characteristics of Persons in Engineering and Scientific Occupations: 1972**, Technical Paper No. 33, U.S. Government Printing Office, Washington, D.C. 1974.

[2] See U.S. Bureau of the Census, U.S. Census of Population & Housing: 1970, **Procedural History**, PHC(R)-11, Washington, D.C. 1976, Chapter 15, for a description of the various questionnaires used in the 1970 census.

Persons were classified according to the system described in the publication, **1970 Census of Population Alphabetical Index of Industries and Occupations.**[3] Parts of this system essential to an understanding of this study are explained in the following sections of this report.

The 1970 PMS occupational classifications are based on responses to item 22 on the PMS questionnaire. This item, along with related PMS items, is shown in illustration B. Item 22 asked the respondent to specify the kind of work being done in each of his or her three most recent jobs, beginning with the job held in 1972 (or nearest to 1972, if the respondent was not working in 1972) and working backwards. The person's occupation during the time period comparable to that of the 1970 census was selected from this job history. Respondents answered item 22 by entering a code and a description from the reference list (List C, reproduced in appendix A) that accompanied the PMS questionnaire. The essential features of the PMS occupational classification system are also explained below.

Table 1 presents a distribution of the 1970 census science or engineering occupations of the PMS respondents in this study, by their detailed occupations in 1970 according to the 1972 PMS. Had the PMS and the census classified persons into corresponding categories, all cases in the table would be within cells located on the diagonal. This study was undertaken to learn why significant numbers of cases are located in off-diagonal cells.

This research does not permit statements about the overall accuracy of the census figures on the number of persons in each of these science or engineering occupations. For a particular census occupational category, the study was concerned only with the cases for which the PMS classification was in disagreement (i.e., the off-diagonal cases). Since the PMS indicated that these cases did not properly belong in the census category, the cases were reviewed and the most appropriate classification of PMS and census responses was determined. Other census occupational groups, however, were not viewed for evidence, based on the PMS, that some of their members should have been classified to the census category being examined. Nor were the on-diagonal cases reviewed for evidence of misclassification in either source. The study, then, was one-sided; and the PMS estimate of how many persons belong in a census category is within the scope of this research, bounded on its upper limit by the number in the particular census occupation and on its lower limit by the agreement cases.

CORRESPONDENCE BETWEEN THE CENSUS AND THE PMS OCCUPATIONAL CATEGORIES

The first stage of the research was to establish the correspondence between the census and the PMS occupational categories. The PMS categories equivalent to each census category were determined; this correspondence or equivalence was established at both the major-group and detailed levels of occupational classification. The census detailed occupational category "economists," for example, was considered to be equivalent to the detailed PMS occupational category "economists"; the major census group "social scientists" corresponded to the major PMS group "social scientists." The correspondence between the two classification systems is shown in example 1 and by the diagonal of table 1. Persons whose occupations

Illustration A

33–35. Current or most recent job activity

Describe clearly this person's chief job activity or business last week, if any. If he had more than one job, describe the one at which he worked the most hours.

If this person had no job or business last week, give information for last job or business since 1960.

33. Industry

a. For whom did he work? *If now on active duty in the Armed Forces, print "AF" and skip to question 36.*

(Name of company, business, organization, or other employer)

b. What kind of business or industry was this?
Describe activity at location where employed.

(For example: Junior high school, retail supermarket, dairy farm, TV and radio service, auto assembly plant, road construction)

c. Is this mainly— *(Fill one circle)*

○ Manufacturing ○ Retail trade
○ Wholesale trade ○ Other *(agriculture, construction, service, government, etc.)*

34. Occupation

a. What kind of work was he doing?

(For example: TV repairman, sewing machine operator, spray painter, civil engineer, farm operator, farm hand, junior high English teacher)

b. What were his most important activities or duties?

(For example: Types, keeps account books, files, sells cars, operates printing press, cleans buildings, finishes concrete)

c. What was his job title?

35. Was this person— *(Fill one circle)*

Employee of private company, business, or individual, for wages, salary, or commissions... ○
Federal government employee ..... ○
State government employee..... ○
Local government employee *(city, county, etc.)*... ○

Self-employed in own business, professional practice, or farm— ■
Own business not incorporated ..... ○
Own business incorporated ..... ○

Working without pay in family business or farm ○

[3] The full citation is U.S. Bureau of the Census, **1970 Census of Population Alphabetical Index of Industries and Occupations,** U.S. Government Printing Office, Washington, D.C., 1971.

Illustration B

Part IV – EMPLOYMENT PROFILE

In this part of the questionnaire, we are asking questions about your last **THREE** civilian jobs beginning with the major job you held last week (or the last job you held) and working back. Please include all jobs, not just scientific or technical jobs. In answering these questions, consider a change in jobs to have occurred if there were significant changes in your duties, level of responsibility, or occupation, even though you may have continued working for the same employer. Please answer each question for all three jobs. If you had more than one regular job last week, report on the one which you considered to be your primary or most important job. (Information about second current regular job should be reported in question 37.)

	LAST CIVILIAN JOB Job held last week or most recent job Job A	SECOND-TO-LAST CIVILIAN JOB Job B	THIRD-TO-LAST CIVILIAN JOB Job C
20. For whom did you work? Name of company, business, organization, government agency, or other employer (or self-employed)	Name	Name	Name
Location where you were employed	City or county 111	City or county 112	City or county 113
	State, foreign country 114	State, foreign country 115	State, foreign country 116
21. What kind of business was this? Enter code and description from List B. If the organization conducted its activities at different locations, enter the description of the activity at the location where you were employed.	117 Code / Description	118 Code / Description	119 Code / Description
22. What kind of work were you doing? Enter code and description from List C.	120 Code / Description	121 Code / Description	122 Code / Description
23. What were your most important activities or duties? For example: design electronic mechanisms in the industrial instrument industry, or teach elementary and advanced courses in physics, or gather and analyze statistical data on wholesale price movements.	123	124	125
24. What was your job title?			

	(Mark only one box)	(Mark only one box)	(Mark only one box)
26. Were you primarily – 1 – Employee of private company, business, or individual for wages, salary, or commissions?	132 1 ☐	133 1 ☐	134 1 ☐
2 – Employee of non-profit organization (except government)?	2 ☐	2 ☐	2 ☐
3 – Federal Government employee?	3 ☐	3 ☐	3 ☐
4 – State government employee?	4 ☐	4 ☐	4 ☐
5 – Local government employee (city, county, etc.)?	5 ☐	5 ☐	5 ☐
Self-employed in own business, professional practice, or farm – 6 – Own business – not incorporated?	6 ☐	6 ☐	6 ☐
7 – Own business – incorporated?	7 ☐	7 ☐	7 ☐
8 – Working without pay in family business or farm?	8 ☐	8 ☐	8 ☐
27. Did you usually work full-time or part-time?	135 1 ☐ Full-time 2 ☐ Part-time	136 1 ☐ Full-time 2 ☐ Part-time	137 1 ☐ Full-time 2 ☐ Part-time
28. Between what dates did you hold this position? (Enter month and year for each job)	From 138	From 139	From 140
	To 141 x ☐ Or last week	To 142	To 143

correspond in the PMS and census are known as "matches"; those whose occupations do not correspond are "mismatches." The mismatches were the focus of this research. Table 2 presents a distribution of matches and mismatches within each detailed census occupation.

THE SAMPLE

The total number of mismatches was 19,620 out of a universe of 34,938. In choosing the sample for the study, these mismatches were first separated according to six major census occupational groups: (1) operations and computer specialists, (2) engineers, (3) mathematical specialists, (4) life scientists, (5) physical scientists, and (6) social scientists. Each major census occupational group was then divided into major-group level and detailed-level mismatches. The detailed-level mismatches are cases whose major occupational category in the census is the counterpart of their major occupational category in the PMS, but whose detailed occupation in the one is not the counterpart of their detailed category in the other. The major-group level mismatches are cases whose PMS and census categories do not agree even at the major-group level. Table 2 shows the distribution of major-group and detailed-level mismatches within each detailed census occupation.

The mismatches were separated into a total of 12 sampling groups—the major group level mismatches and the detailed-level mismatches within each of the six major occupational groups.

Example 1.--Correspondence Between Census and PMS Occupational Categories

Detailed 1970 census occupation and code	Corresponding detailed PMS occupational groups (identified by code from Reference List C[1])
OPERATION AND COMPUTER SPECIALISTS	
Computer programmers (003)	413
Computer systems analysts (004)	414
Computer specialists, n.e.c. (005)	415, 416
Operations and systems researchers and analysts (055)	420
ENGINEERS	
Aeronautical and astronautical engineers (006)	401, 439
Chemical engineers (010)	403
Civil engineers (011)	404, 411
Electrical and electronic engineers (012)	405, 410
Industrial engineers (013)	406
Mechanical engineers (014)	407
Metallurgical and material engineers (015)	408
Mining engineers (020)	409
Petroleum engineers (021)	409
Sales engineers (022)	412
Engineers, n.e.c. (023)	402, 411, 412
Engineering teachers (111)*	401-412
MATHEMATICAL SPECIALISTS	
Actuaries (034)	417
Mathematicians (035)	418
Statisticians (036)	419
Mathematics teachers (112)*	417-419
LIFE SCIENTISTS	
Agricultural scientists (042)	421
Agricultural teachers (102)*	421
Biological scientists (044)	422, 426
Biology teachers (104)*	422, 426
Foresters and conservationists (025)[2]	421
PHYSICAL SCIENTISTS	
Atmospheric and space scientists (043)	428
Geologists (051)	425
Marine scientists (052)	425
Atmospheric, earth, marine, and space teachers (103)*	425, 428
Life and physical scientists, n.e.c. (054)	428
Chemists (045)	423, 424
Chemistry teachers (105)*	423, 424
Physicists and astronomers (053)	427
Physics teachers (110)*	427
SOCIAL SCIENTISTS	
Economists (091)	429
Economics teachers (116)*	429
Psychologists (093)	430
Psychology teachers (114)*	430
Sociologists (094)	431
Sociology teachers (121)*	431
Political scientists (092)	432
Urban and regional planners (095)	432
Social scientists, n.e.c. (096)	432
Social science teachers, n.e.c. (122)*	431, 432

n.e.c. Not elsewhere classified.
*College and university.
[1]See appendix A.
[2]With 4 or more years of college.

The sample, approximately 1,260 cases, was chosen by a random sampling technique within each of these sampling groups. Table 3 presents the total number of sample cases within each of the 12 sampling groups. Appendix F provides a further explanation of the sample design.

REASONS FOR DISAGREEMENT

The occupational classification that each case received in either the census or the PMS was the output of the respective occupational classification system. To discover why these outputs differed, the response, which was the input to each system, and the classification systems themselves had to be examined. Each classification system consisted of (1) a collection vehicle (i.e., the questionnaire), and (2) a method for converting the response into a three-digit occupational code.

THE RESPONSE

The census questionnaire collected responses about occupation mainly in item 34 (see illustration A). The three parts of this item correspond to items 22, 23, and 24 on the PMS questionnaire. To answer the census occupational question, the respondent was free to choose his or her own words and was not limited to a predefined list of occupational descriptions. For this reason, the census question is often referred to as an "open-ended" question. All parts of the question were used as inputs to the census classification system.

On the PMS questionnaire, items 22, 23, and 24 asked for occupational data (see illustration B). Only item 22, however, entered directly into the occupational classification system. The written replies to questions 23 and 24 were used during the clerical processing stage of the PMS to clarify the meaning of responses to item 22; and, from the point of view of this study, the replies in questions 23 and 24 were essential to a complete understanding of the information about "kind of work" that the respondent translated into a code in item 22. In contrast to the open-ended census question, PMS item 22 had a limited number of response possibilities. The respondent was asked to enter a code and an occupational description from List C (see appendix A) in answer to the question "What kind of work were you doing?" PMS responses were not entirely restricted to reference-list categories, however, because List C provided residual categories the respondent could use if none of the listed descriptions accurately described the occupation. Therefore, the PMS response contained elements of the PMS classification system because the codes on List C were used in both the response and, as discussed in the next section, in the PMS classification system. A procedure using the information in all three PMS items (22, 23, and 24) was employed to separate the PMS classification system elements from the response, so that an unadulterated PMS response could be compared with the census response. This procedure is explained in appendix B.

THE CLASSIFICATION SYSTEM: COLLECTION VEHICLES

Item 34 on the census questionnaire was part of a battery of questions (see illustration A) dealing with the person's current or most recent job activity. Each person in this study was identified as being employed in 1970, and thus, should have answered these questions according to the instruction to "describe clearly (his or her) chief job activity or business last week, if any." The data concerning the census occupation refer, therefore, to the calendar week prior to the date on which the respondent completed the questionnaire or was interviewed by a census interviewer. Because the week of enumeration was not the same for all persons, the reference week for the occupational data is not entirely uniform. If the respondent held more than one job during the reference week, the one at which the most hours were worked was to be described.

In contrast to the census, the PMS collected occupational data as part of a series of questions that asked the respondent to provide a job history (see illustration B). The respondent was to answer questions concerning the last three civilian jobs, beginning with the major job held last week (i.e., the week prior to the date on which the questionnaire was filled out) and working back in time. In answering the questions, the person was to consider that a change in jobs had occurred if there were significant changes in duties, level of responsibility, or occupation, even if there was no change in employer. If the respondent had more than one regular job, the job considered to be the primary or most important one was to be reported. The census gave the person a yardstick for determining primary job (i.e., the one at which the greatest number of hours were worked), but the PMS left the determination up to the respondent's own consideration of "most important" job.

THE CLASSIFICATION SYSTEM: CLASSIFICATION SCHEMES

The final step in the occupational classification systems was the assignment of numeric codes to the written occupational descriptions. These codes represent detailed occupational categories and are the basis upon which the tabulations by occupation, such as those in table 1, were made.

In the census, the written responses were converted to identifying codes by relating the description to an entry in the **Alphabetical Index of Industries and Occupations.** The conversion was made by clerical coders during the processing stage of the census. These codes were then entered onto computer tape.

As mentioned above, the chief census occupational question (item 34) had three sections: (a) kind of work, (b) most important work activities or duties, and (c) job title. Using the entries in these three sections, the census coder attempted to arrive at an occupation for the person that matched one of the titles in the **Alphabetical Index.** Illustration C shows the occupational titles of the detailed category "chemists." Based upon this occupational title, and, in some instances, upon information provided by the respondent in the industry question (question 33) and/or the class-of-worker question (question 35), the respondent was given an occupational code. The detailed census occupational categories, their associated codes, and the occupational titles they include, constitute the

1970 census occupational classification scheme.[4] The manner in which occupational codes were assigned by the census means that the detailed census occupational categories are defined in terms of a set of occupational titles. Persons with any one of the titles subsumed by a particular detailed category were to be assigned the code of that category. These titles are shown in the companion publication of the **Alphabetical Index** entitled the **Classified Index of Industries and Occupation.**[5]

In the PMS, providing an occupational description and coding that description were products of the same activity, which was performed by the respondent. As stated previously, to answer PMS question 22, the respondent was referred to a list of occupational descriptions, List C, which was enclosed with the questionnaire; each description on this list is accompanied by a three-digit code. The respondent was requested to scan the entire list of occupational descriptions, to choose the entry that was most appropriate in describing his or her kind of work, and then to enter the description and the appropriate code in the assigned areas of question 22. If the respondent could not find exactly the right description, he or she was instructed to choose one that came nearest to it in providing a proper description, or if none of the descriptions was appropriate, the respondent was asked to enter code 469, the code for the "other occupations" category, and to include a brief occupational description in the space provided on the questionnaire. In either case, the person's PMS occupational category was determined by the code entered in the code box of PMS item 22.

The entries of PMS List C, in effect, constitute the occupational classification scheme of the PMS. In most cases, these entries represent detailed census occupations, and they were assumed to include all the occupational titles which the corresponding census category included. On List C, however, none of the specific occupational titles subsumed by the categories was shown (except for a few categories, such as "425 earth and marine scientists"). The structure of the PMS scheme differs, therefore, from that of the census scheme in that the PMS structure does not make available to the coder (i.e., the respondent in the PMS) all the subcategories or occupational titles included under each detailed occupation. The PMS structure also differs from the census one in that the census specifies industry and/or class-of-worker qualifications for inclusion in some occupational categories, whereas this is not done in the PMS.

DEFINITIONS OF MISMATCH CAUSES

The reasons for mismatches between the census and the PMS occupational classifications derive from circumstances within or between the elements of the two systems explained above. That

[4] The word "scheme" is used here and in the description of its PMS counterpart to distinguish the lists of detailed occupational categories from the classification systems of which they, along with the questionnaires and the coding rules, are a part. The list of census categories is known, however, in the **Alphabetical Index** and in the **Classified Index** as the "Occupational Classification System," a practice not followed in this report.

[5] The full citation is U.S. Bureau of the Census, **1970 Census of Population Classified Index of Industries and Occupations**, U.S. Government Printing Office, Washington, D.C., 1971.

Illustration C

Occupational Titles for Chemists

Note: The numerical or alphabetical codes following any title indicate that a person with an item 34 return of the given occupational title is classified as a "chemist" only if the accompanying industry code is one of these codes. For more information, see the Alphabetical Index or the Classified Index.

045 Chemistry

Agricultural chemist
Analyst–047-057
Analytical chemist–(897)
Assayer–(748)
Atmospheric chemist

Biochemist–(897)
Biological chemist–(897)
Ceramic chemist
Ceramist–119, 128, 137
Cereal chemist

Chemical analyst
Chemical economist
Chemical educator–Exc. K.858
Chemical librarian
Chemist–(897)

Coagulating-drying supervisor–347-369
Coal chemist–729
Color consultant–307-318.349
Color maker–347-358, 368, 369
Color maker, formulator–307-318, 349, 388

Color matcher–347-358, 368, 369
Colorist–347-358, 368, 369
Colorist, formulator–307-318, 349
Compounder, formulator–C, 107-398
Control chemist–328

Dairy chemist
Dye colorist, formulator–307-318, 349
Dye expert–347-358, 368, 369

Electrochemist–(897)
Fermentologist–289
Food analyst
Food chemist
Food-processing chemist

Food scientist
Food technologist
Formulator–347-369
Glass technologist–119
Gold assayer–(748)

Industrial chemist
Inorganic chemist
Inspector
  Chemical–347-358, 367-369
Juice standardizer–278

Juice tester–278
Laboratory chemist
Medical chemist–(897)
Metallographer
Metallurgical specialist
Metallurgist
Mix chemist

Nutritional chemist–(897)

Oil expert–377
Organic chemist

Paint formulator–359
Patent chemist
Pesticide chemist
Pharmaceutical analyst
Pharmaceutical chemist–(897)

Pharmacognosist
Physical biochemist
Physical chemist–(897)
Physiological chemist–(897)
Powder expert

Quality-control chemist
Rubber chemist
Rubber compounder, formulator–379
Soil chemist–(897)
Spectrograph operator–Exc. D. 139-238, 759

Spectrographer–Exc D. 139-238, 759
Spectroscopist–Exc. D. 139-238, 759
Teacher
  Chemistry–Exc. K, 858
Textile chemist

Textile colorist, formulator
Textile techologist
Tower-control man–349
Water chemist

Source: U.S. Bureau of the Census, 1970 Census of Population, Classified Index of Industries and Occupations, U.S. Government Printing Office, Washington, D.C., 1971.

is, the general causes lie in differences between the way persons responded or in the way these responses were classified by either system. Example 2 summarizes these causes. The following paragraphs of this section describe the specific causes included under the two general headings: (a) classification-system causes, and (b) response causes.

I. CLASSIFICATION-SYSTEM CAUSES

This section describes the causes for classification differences arising when the responses in the census and the PMS are the same or essentially the same. Since these differences must then derive from the classification systems, the causes are thus referred to as "classification-system causes". This group of causes has two major subcategories: (A) errors and (B) systemic differences. There are three kinds of errors: (1) census coding errors, (2) PMS coding errors, and (3) processing errors. There are two kinds of systemic differences: (1) structural differences, and (2) methodological differences. Each of these specific causes is explained below.

A. Errors. Errors occurred when the wrong code was assigned to an occupational description because the rules of a particular system were violated. If the violation had not occurred, the census occupational category and the PMS classification would have corresponded. Errors in each source were determined independently; that is, in the identification of a census error no reference was made to the PMS and vice versa.

1. **Census Coding Errors.** Census coding errors occurred when the written descriptions provided by the respondent on the 1970 census questionnaire were improperly coded according to the census coding rules and procedures. In some cases, an obvious coding error was made. For example, the respondent reported "pharmacist" in question 34a, "dispenses drugs" in question 34b, and "staff pharmacist" in question 34c, but was given occupational code 045 ("chemists") instead of code 064 ("pharmacists"). In other instances, the coding error was not as straightforward. The coding of the following written description illustrates this type of error. The respondent entered "biologist" in question 34a, "studies wildlife" in question 34b, and "wildlife biologist" in question 34c. The clerk coded this person to code 044 ("biological scientists") because of the written description "biologist" in question 34a. The additional information in questions 34b and 34c, however, indicated that, according to the **Alphabetical Index**, the proper occupation for this person was "agricultural scientists," since this occupation includes the title "wildlife biologist."

2. **PMS Coding Errors.** PMS coding errors resulted from the failure of the respondent to code an occupational description correctly in accordance with the rules of List C. There are two varieties of these errors. In the first kind, the respondent entered an occupational description in question 22 that was identical to one of those on List C, but failed to transcribe the correct code. The second kind of PMS coding error occurred when the respondent failed to note that category 451 of List C, "teachers, college and university," excluded college or university teachers of engineering and science, and that these engineering and science teachers were to use codes 401-432. The result of such failures is that the respondent clearly indicated in questions 22-24 that he or she was a professor of a specified engineering or scientific discipline, but entered code 451 ("teacher, college and university").

Example 2—Causes of Mismatches

I. Classification-system causes
- A. Errors
  - 1. Census coding errors
  - 2. PMS coding errors
  - 3. Processing errors
- B. Systemic differences
  - 1. Structural differences
    - (a) Subcategory misclassifications
    - (b) Residual-category classifications
  - 2. Methodological differences
    - (a) Managerial concept
    - (b) Other methodological differences
      - (1) Dual occupations
      - (2) Cascade rule

II. Response causes
- A. Insufficient responses
  - 1. Census insufficient responses
    - (a) Deficient responses
    - (b) Ambiguous responses
      - (1) Discretionary cases
      - (2) Probability cases
  - 2. PMS insufficient responses
- B. Conflicting responses
  - 1. Retrospection errors
  - 2. Reference period differences
  - 3. "Job history" problems

3. **Processing Errors.** Three kinds of processing errors were found: (a) data-recording errors, (b) editing errors, and (c) reference period misidentifications. Examples of the first two kinds of errors were found only in relation to the PMS classification system. Data-recording errors occurred when the correct code was miskeyed during the keying of occupational codes onto magnetic tape. Editing errors occurred when PMS clerical editors, in violation of the editing rules, substituted incorrect data for the correct entry made by the respondent. Reference period misidentifications resulted from assumptions made in the present study; specifically, these errors were related to the decision to use April 1970 as the period in which to locate the person's 1970 PMS occupation from the history of most recent jobs. As explained previously, the reference period for the census responses varied but often was the last week of March 1970. Thus, a respondent who had a different occupation in April 1970 from that held during the census reference week would have been classified as a mismatch. Fortunately, reference period misclassifications constitute a very minor cause of mismatches.

B. Systemic Differences. The PMS and census classification

systems differ from one another in two principal ways: (1) in the level of detail of the classification scheme, or, in other words, in the structure of the categories composing the scheme, and (2) in the methods or rules by which a description is placed into an occupational category. These differences create two causes of occupational classification mismatches: (1) structural differences, and (2) methodological differences.

1. **Structural Differences.** As mentioned before, the detailed census occupational categories are second-level groupings that include a number of specific (or first-level) occupational titles. A person who was identified by the census questions to have any one of the specific titles included in a census occupational category was placed into that occupational category. The PMS classification scheme, on the other hand, provided the respondent with the occupational categories but not with their associated occupational titles. For example, illustration C, shown in the section on "Classification Schemes," lists 76 titles for the census category "chemists"; on PMS List C, only the category "chemists" appears. The PMS also provided the respondent with broad residual categories (such as "412 engineer, other fields"), whereas the census usually assigned a specific occupational category to each case. In relation to the census occupational category, a respondent who reported the same occupational title in the PMS as in the census could have picked a corresponding PMS occupation, a noncorresponding PMS occupation, or a residual PMS category to describe that occupation. The latter two choices gave rise to the two kinds of systemic differences: (a) subcategory misclassifications, and (b) residual-category classifications.

a. **Subcategory misclassifications.** A respondent often chose the wrong PMS category to describe the occupational title clearly indicated in PMS questions 22-24. It must be assumed that, had PMS List C provided all the occupational titles included by each occupational category, the respondent would have chosen the PMS counterpart of his or her census category.

Another type of subcategory misclassification arose because the census sometimes classified persons with a specific occupational title into one of two or more detailed occupational categories, depending upon the industry in which they worked. The PMS did not provide the respondent with such industry restrictions for the PMS counterparts of these census categories.

b. **Residual-category classifications.** Unlike subcategory misclassifications, in which the respondent classified an occupational title to a specific PMS category, a residual-category classification occurred when the respondent incorrectly classified his or her occupational title under one of the residual categories of the major PMS occupation groups (that is, into occupational categories with codes 412, 416, 428, 432), or into the broadest residual category "469 other occupations, not specified above."

2. **Methodological Differences.** Often, the occupational information supplied in the census was ambiguous. The clerks, however, had to code this information to a unique occupation, so they were often forced to make choices among two or more possible occupational categories. There were rules (see appendix C) which guided the coders in their choice of a census occupational code. The differences between these rules and the unspecified rules or methods used by the PMS respondents led to a class of causes for occupational differences known as "methodological differences." The various types of methodological differences are described below.

a. **Managerial concept.** This major type of methodological difference concerned persons who reported in the census and in the PMS that they were managers within a specific field of science or engineering. For example, in the census a person reported "chemical engineer-management" in question 34a, "management" in question 34b, and "vice-president" in question 34c. A census rule, referred to as the "lowest-code" rule (see section "a" of appendix C), specified that if a respondent indicated that his or her job involved two distinctive occupations, he or she was to be placed in the occupational category with the lowest code. The application of this rule to the occupations within the scope of this study meant that fields of specialization were favored over managerial functions. Thus, in the example, the coder assigned the person code 010 ("chemical engineer"). This same respondent supplied a similar written description on the PMS, but coded himself to "455 administrators, managers, or officials, all other, excluding self-employed." Had the census rules placed more emphasis on the managerial activities, there would have been a match between the census and PMS occupations for this case.

b. **Other methodological differences.** In some cases, the differences arose because the census lowest-code rule was applied when the respondent reported a job as involving two specific scientific or engineering occupations, such as "programmer-systems analyst." In this example, the person was coded in the census to "programmers," instead of to "computer systems analysts." In the PMS, each of the dual occupations is represented by a separate code, but only one code could be placed in the code box of the PMS occupational item. Because the code in this box is the sole basis for the PMS occupational classification, the respondent was forced to choose the code of one of the dual occupations. Often, his or her choice is not a counterpart of the occupation assigned in the census.

There is also a procedure, called the "cascade rule," that was in effect during some of the census processing. Basically, the cascade rule allowed the census coder to assign an occupational code without reference to the responses in parts "b" and "c" of question 34 if the entry in question 34a provided an adequate match with an **Alphabetical Index** entry. This rule, however, caused some respondents to be placed into an inappropriate census occupational category. These cases usually involved persons who described a professional occupation in question 34a, but indicated in 34b and 34c that they were clerical workers or technicians. In the PMS, the person often chose one of the clerical codes or technician codes to classify his or her occupation.

II. RESPONSE CAUSES

The section above discusses the reasons for classification differences occurring when the responses are essentially the

same on both the census and the PMS. Differences arising from the responses themselves, not from the classification systems, are the subject of this section. There are two classes of response causes: (A) insufficient responses, of which there are two subcategories—(1) census insufficient responses, and (2) PMS insufficient responses; and (B) conflicting responses.

A. **Insufficient Responses.** The PMS response when it differs from the census response is either consistent or in conflict with that response. To be consistent, a PMS response contains either more or less information than the census response, but none of the PMS information contradicts any of the information in the census response.

1. **Census Insufficient Responses.** When the PMS response adds important information to the census response, so that together the two responses indicate that the person's PMS occupation is a more appropriate choice, the cause of the resulting occupational mismatch is known as "census insufficient response."

a. **Deficient responses.** These occurred when the response as given led unalterably and unambiguously to the choice of a detailed census occupational category; however, additional information not supplied in the census indicates that the person belongs in a different category.

b. **Ambiguous responses.** These refer to cases in which the information is so ambiguous or so general that a choice among more than one detailed census category is possible. The "ambiguous responses" are further divided into two classes, according to how they were classified into a census occupational category. The first class, known as "discretionary" cases, contains responses with information so general that the person might reasonably be classified into a number of categories; the coders, therefore, exercised their judgment and experience to place these cases into categories.[6] The second class of ambiguous responses, known as "probability" cases, are those in which the respondent reported that he or she was working in a general category, as opposed to a detailed one, within a major occupation group such as "engineers." An example of this kind of response is that of the respondent who entered "design engineer," but did not indicate the specific kind of design engineer. In such cases, the person was assigned to a detailed engineering occupational category (such as "mechanical engineer") based upon the industry designation. This was done in an effort to choose the person's most likely occupation among a number of possibilities.

2. **PMS insufficient responses.** This cause of mismatches displays the following characteristics: the person in the PMS enters a code and description of a detailed PMS category; however, in view of the person's census response, it is almost certain that the person has committed a PMS coding error and that his or her "true" PMS occupation is a counterpart of his or her census occupation or that the cause of the classification difference is some kind of methodological difference. An example of the former instance is that of the respondent who entered PMS code 451 ("teachers, college or university, excluding engineering and science") and only the word "professor" in PMS items 22, 23, and 24; on the census form, however, the respondent indicated that he or she was a college professor of mathematics. It is nearly certain, therefore, that the respondent has committed a PMS coding error. The "PMS insufficient response" cases should perhaps be called "PMS insufficient **evidence**" cases, because the entry of a PMS code is always sufficient to enable the person to be classified to a unique PMS category, but it is not sufficient evidence that the person is classified to the correct category, nor can it rule out the possibility that the mismatch is caused by a methodological difference.

B. **Conflicting Responses.** The second kind of PMS-census response differences are those in which the PMS information conflicts with or contradicts that given in the census. Such conflicts lead, of course, to occupational classification mismatches. Some of these conflicts may have come about because of imperfections in the way persons expressed their occupational descriptions in one or the other of the surveys. But aside from such imperfections, there are also reasons inherent in the differences between the ways the data were collected for persons to specify an occupational title in the PMS that contradicted the one they provided in the census. The identification of the causes of conflicting responses is a much more speculative operation than the identification of other kinds of causes; and the isolation of a cause for any particular classification difference is impossible. In general, however, the conflicts flow from the following causes:

1. **Retrospection Errors.** As mentioned above, the census response refers to the activity performed by the respondent during the week previous to that in which the questionnaire was completed. The PMS response about occupation in 1970, on the other hand, was made approximately 2 years after the activity was performed. Conflicting responses, therefore, may have arisen because of errors in retrospection.

2. **Reference Period Differences.** The lack of a uniform reference week for the occupational data in the census, in contrast to the uniform time period chosen in the PMS to locate the person's occupation in 1970, may also have contributed to conflicting responses. The person may have been describing an occupation in the census that was held before or after the one reported in the PMS.

3. **"Job History" Problems.** Because PMS data on occupation in 1970 were collected as part of a job history, it was possible for persons to err in reporting the beginning and ending dates of their most recent three jobs. Such errors may have led to their reporting an occupation for the PMS reference period that they held before or after this period. This kind of error was possible to detect, in some cases, by noting any differences between the company name of the PMS occupation (given in

[6] The authors identified two kinds of discretionary cases, which are mentioned here briefly. On the one hand, there are those in which one can tell from the combination of the information from both sources (the census and the PMS) what the correct and unique census category should be. On the other hand, there are inadequate responses in which the addition of the PMS written response to the census data does not help in establishing the correct census category, and for which the "correct" occupational category must be considered to be the census counterpart of the one specified by the person's PMS code.

PMS item 20) and that of the census occupation (census question 33a). Also, an occupation the person held later than 1970 (the PMS asked for data on jobs held in 1972 or earlier) may have influenced the PMS description of the occupation held in 1970.

SUMMARY OF THE CAUSES OF MISMATCHES

The causes of mismatches discussed in the previous section have been collapsed into eight detailed and four major groups in tables A through G, which are presented in the "Analysis of Results" section. The results of the research are presented only for these collapsed groupings because they represent the most detailed level at which the results are statistically significant.[7] The major groups of causes are as follows: (1) errors, (2) response causes, (3) structural differences, and (4) methodological differences.

ANALYSIS OF RESULTS

The goal of this project is to evaluate the success of the 1970 census occupational classification system in placing persons correctly into a number of detailed science or engineering occupations. This goal was approached indirectly, first by dividing the cases of the study into matches and mismatches, and then by determining a cause for each mismatch. It was thus possible to measure the census success by the process explained below.

Although the word "correct," when applied to a census occupational categorization, can be variously defined, the results of this study will be analyzed and interpreted from the perspective of a definition recognizing a "correct census categorization" as one that assigns a person with a given set of occupational characteristics to a category defined as uniquely including all persons with such characteristics. In effect, the results will be asked to answer the question: "How well did the 1970 census occupational classification system accomplish what it set out to do?" The answers should shed light on the obstacles that stood in the system's way. These obstacles will be examined and some ways of possibly minimizing or eliminating them will be suggested.

The initial indications of the correctness of the census occupational categorizations of the persons included in this study are made in table 1. In that table, the matches (the cases on the diagonal) indicate that the cases they represent are correctly categorized in the census, whereas the mismatches make the opposite indication. Upon further study the mismatches were classified as shown in tables A through G according to the causes of mismatches. Implicit in each cause of mismatches is a further indication of whether the census categorization for a case is correct, and to this further indication is attached a particular degree of certainty.

The causes of mismatches, in fact, can be located on a scale that expresses (1) the value of each cause as an indicator of the correctness of a census categorization, and (2) the degree of confidence that can be placed in this value. At one end of the scale are the census coding errors, other methodological differences, and the insufficient census responses; it is certain that cases associated with the first two categories, and nearly certain that cases associated with the third, are incorrectly classified in the census. At the other end of the scale are the structural differences, the managerial-concept methodological differences, and the PMS coding errors. The PMS information from these cases confirms or virtually confirms that their census categorizations are correct. Close in concept to these latter cases are the PMS insufficient responses, for which there is substantial, but not conclusive, evidence to support the correctness of the census categorizations. Finally, in the middle of the scale are the conflicting responses. The PMS information for these cases neither affirms nor denies the correctness of their census categorizations. For convenience, this scale will be referred to as the "C-scale."[8] Illustration D presents a schematic representation of the C-scale.

The success of the 1970 census occupational classification system can be measured by the PMS, then, in terms of the proportion of matches and of the proportions of mismatches on various parts of the C-scale. This analysis, for the most part, will examine the results from the perspective of this measure, with the discussion being confined to the mismatches. The data in tables A through G are arranged according to the cause of mismatches. These data will first be used to describe the contribution of each cause to the total number of mismatches, and then they will be interpreted in terms of the C-scale. (See appendix F for a discussion of the estimation procedure and of the reliability of the estimates for the data in tables A through G.)

There is another definition of a "correct" census categorization that will also be discussed. According to this definition, a person is correctly categorized if he or she is placed in the census category that best reflects the kind of work he or she is doing. The complete determination of whether a case is categorized correctly according to this definition is, unfortunately, outside the scope of this research. Nevertheless, the structural differences and the methodological differences, especially cases involving the managerial concept, can be interpreted as indicating some belief on the part of PMS respondents that their census category does not provide the best possible reflection of their occupational characteristics. Here it is not a question of whether the census classification system accomplished what it set out to do, but whether its goals are the best possible means of summarizing the kinds of work being described. Thus, structural-difference mismatches may be considered as disputing the arrangement of occupational titles within the census classification scheme. For example, the occupational title "financial analyst" is listed in the census

[7] See appendix F for a discussion of the estimation procedure and the reliability of the estimates for the data in tables A through G.

[8] The obverse of the above scale is one that expresses the value of each mismatch cause in supporting the challenge to the validity of census categorizations made by the mismatched cases in table 1. On this scale, the census coding errors and the other methodological differences completely confirm, and the census insufficient responses virtually confirm, these initial challenges. The structural differences, the managerial-concept methodological differences, and the PMS coding errors remove the challenges, whereas the PMS insufficient responses considerably weaken them. In the middle, of course, are the conflicting responses, which do not affect the initial challenges.

under the detailed category "economists." Persons who entered this title in the PMS, but classified themselves as "accountants," may be indicating that "accountant" is a better description than "economist" of the kind of work they did. Similarly, persons whose census and PMS classifications differ because of methodological differences may be indicating that the census rules caused them to be placed in categories such as "chemists" or "mechanical engineers" that are less accurate descriptions of their work than "managers or administrators."

When viewing the data on structural and methodological differences from the viewpoint of this second definition of a "correct" census categorization, however, it is important to remember that these data present only part of the story. They reveal instances where the PMS respondents may be disagreeing with the census classification scheme or classification rules. What is not shown, and what cannot be known until a study of the matched cases is made, are the instances where the PMS respondents *agree* that the census scheme or rules provide the best summarization of their work. It is not known, for example, how many persons with managerial responsibilities agree, according to their PMS responses, with the census that "chemists" or "mechanical engineers" is a better description of their work than "managers or administrators."

ALL OCCUPATIONS

Table A presents the results of this research for all the mismatches, regardless of occupational group. The findings for individual census occupational groups are presented in tables B through G.

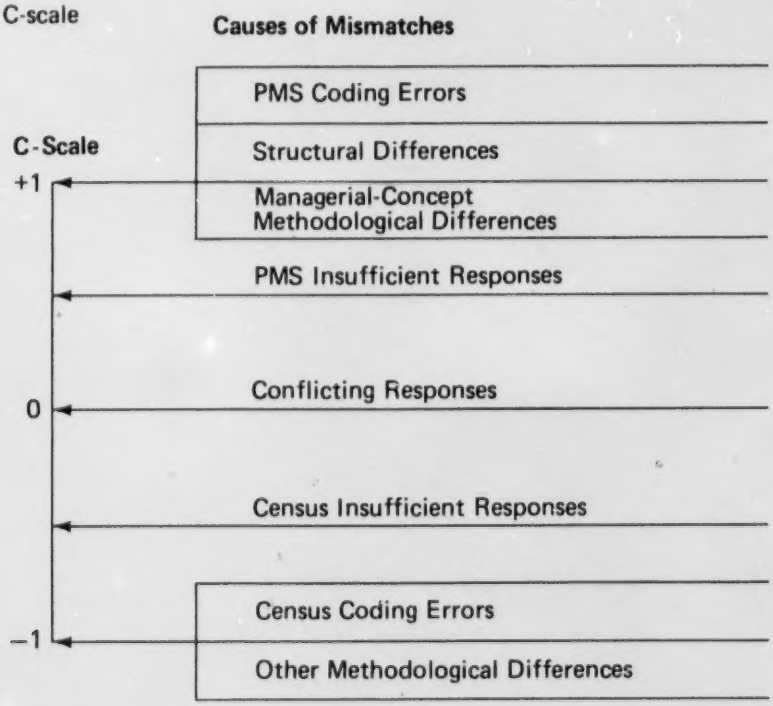
Table A shows that census coding errors, structural differences, and conflicting responses are responsible for about the same proportion of all mismatches at 22 percent, 24 percent, and 25 percent, respectively. Moreover, methodological differences, census insufficient responses, and PMS coding and processing errors are also responsible for about the same proportion of all mismatches at 8 percent, 10 percent, and 10 percent, respectively. The PMS insufficient responses account for 2 percent of all mismatches.

Interpreting these findings in terms of the C-scale reveals that, based on evidence from the sample used in this study, about 33 percent of the mismatches are incorrectly classified in the census, whereas perhaps as many as 42 percent are correctly classified. These percentages correspond to the proportions of mismatches in the "census coding error" and "census insufficient response" categories and in all the other cause categories except "conflicting responses," respectively.

The major-group level mismatches are distributed among the cause categories in a pattern somewhat similar to that for all mismatches. When they are located on the C-scale, their distribution is similar to that displayed by the same placement of all mismatches. About 45 percent of the major-group mismatches are probably correctly classified in the census; and about 29 percent are misclassified. Of the 29 percent, about

Illustration D

Schematic representation of the C-scale



Note: In this schematic, the C-Scale is shown as a number line whose values range from +1 to −1. The absolute magnitudes of the numbers signify degrees of certainty and the signs of the numbers signify correctness. Thus, all values fall between an absolute value of "0", indicating complete uncertainty, and an absolute value of "1", indicating complete certainty. The "+" sign attached to a value indicates that the census categorization is correct; and the "−" sign, that it is incorrect.

two-thirds are caused by census coding errors, and the remaining third by census insufficient responses or by other methodological differences.

An incorrect census categorization at the major-group level, of course, represents a much more serious failing of the census classification system than does one at the detailed level. In view of the initial indications, as shown in tables 1 and 2, the discovery that only 29 percent of the major-group level mismatches are incorrectly classified is encouraging. This 29 percent represents only about 16 percent of all mismatches (major-group and detailed levels). In about 80 percent of the mismatches, therefore, the census classification scheme succeeded in placing persons at least within the correct major occupational group.

At the detailed level of mismatches, table A reveals that as many as 37 percent of the cases may be correctly classified in the census, with almost all of these cases involving structural differences, managerial-concept methodological differences, or PMS coding and processing errors. The table shows that 38 percent of the mismatches are incorrectly categorized in the census, 24 percent because of census coding errors, 12 percent because of census insufficient responses, and about 3 percent because of other methodological differences.

Census coding error appears to be a significant cause of census misclassification, constituting about two-thirds of the cases for which the evidence from the sample indicates that the census system has failed. Errors, of course, occur in all coding operations, some stemming from systematic causes and others occurring through chance oversights. It could not be established conclusively into which of these two categories any particular census coding error fell. Nevertheless, this research indicates that a major cause of coding errors is the failure, for systematic reasons, of the coding clerks to use all the information available to them. Three such systematic reasons were identified. First, coders often placed a person in an occupational category based solely on the written entry in the first part of the three-part occupational question, even if this entry was insufficient. Second, coders tended to key on one word of the written response when determining the occupational category of the respondent; for example, a coder would spot the word "statistical" in question 34a and assign the person to the detailed occupational category "statisticians" instead of using all the available information in question 34a to 34c, which would have caused the respondent to be coded to "statistical clerks." Third, when coding some occupational titles, coders did not consult the **Alphabetical Index** because they incorrectly assumed that they knew the occupational category of the title in question; for example, the occupational title "computer programming manager" was often coded to "computer programmers" instead of to its proper occupational category, "computer systems analysts."

A second definition of "correctness" is mentioned above, and it is suggested that structural and methodological differences may be indexes of how well the 1970 census classification system succeeded according to this definition. Structural differences, it is said, may indicate disagreement over the classification of various occupational titles or characteristics. In this regard, subcategory misclassifications, a type of structural

Table A. All Occupational Groups by Causes of Mismatches Between the Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error	Number	Percent	Standard error	Number	Percent	Standard error
All causes, total	[1]1,262	100.0	(X)	[1]696	100.0	(X)	566	100.0	(X)
Errors, total	393	31.1	1.3	249	35.8	1.8	144	25.4	1.8
Census coding errors	273	21.6	1.2	140	20.1	1.5	133	23.5	1.8
PMS coding errors[2]	120	9.5	0.8	109	15.7	1.4	11	1.9	0.6
Response causes, total	465	36.8	1.4	248	35.6	1.8	217	38.3	2.0
Conflicting responses	319	25.3	1.2	174	25.0	1.6	145	25.6	1.8
Census insufficient responses	121	9.6	0.8	56	8.0	1.0	65	11.5	1.3
PMS insufficient responses	25	2.0	0.4	18	2.6	0.6	7	1.2	0.4
Structural differences, total	304	24.1	1.2	113	16.2	1.4	191	33.7	2.0
PMS subcategory misclassifications	165	13.1	0.9	71	10.2	1.1	94	16.6	1.6
PMS residual-category classifications	139	11.0	0.9	42	6.0	0.9	97	17.1	1.6
Methodological differences	96	7.6	0.7	82	11.8	1.2	14	2.5	0.7
Managerial concept	75	5.9	0.7	75	10.8	1.2	(X)	(X)	(X)
Other	21	1.7	0.4	7	1.0	0.4	14	2.5	0.7

[1]Includes 4 cases incorrectly included in the sample.
[2]Includes processing errors.

difference would seem to indicate a more serious disagreement than residual-category classifications. In subcategory misclassifications, persons indicated that their occupations were in a different category from the one that had been assigned in the census, whereas in residual-category classifications they indicated simply that the census category was not appropriate without specifying what category would have been more appropriate. The results show that structural differences are about equally divided between the two subcategories, with subcategory misclassifications comprising about 13 percent of all mismatches and residual-category classifications about 11 percent. The entire group of structral differences constitute about 24 percent of all mismatches; this fact could mean that in as many as a quarter of the mismatches the census failed to reflect, at the detailed level of occupational classification, the kind of work the persons were doing.

As expected, structural differences occur more frequently at the detailed level than at the major-group level. It would appear to be more likely that persons would agree with the census that a particular title or set of occupational characteristics should be classified in the major group "engineers," for example, than that it should be placed in the detailed occupation "chemical engineers" rather than in "mining and petroleum engineers." In fact, structural differences do account for a larger proportion of cases among the detailed-level mismatches (34 percent) than among the major-group level ones (16 percent). However, about 6 percent of the major-group level mismatches are residual-category classifications; this 6 percent is particularly significant because, for all of these cases, the PMS respondents indicated that their work was entirely outside the fields of engineering or science. These persons entered codes 436 ("other health occupations"), 448 ("technicians, other fields") or 469 ("other occupations, not specified above").

Methodological differences comprise about 8 percent of all mismatches; most of these differences are managerial-concept methodological differences (6 percent of all mismatches). By definition, a managerial-concept mismatch exists only at the major-group level; at this level, table A shows that this cause is responsible for about 11 percent of such mismatches. Other methodological differences cause about 2 percent of all mismatches.

OPERATIONS AND COMPUTER SPECIALISTS

Among operations and computer specialists, response problems and classification-system causes each contribute approximately half to the mismatch universe (table B). About 46 percent of all mismatches involve either conflicting or insufficient responses. Also, nearly one-third of all mismatches in this group contain errors, primarily census coding errors. Structural and methodological differences together cause approximately 22 percent of the classification differences.

Viewing these results in terms of the C-scale, about half of the operations and computer specialist mismatches are misclassified in the census at either the major-group or detailed levels. In other words, mismatches arising from census coding errors, census insufficient responses, or other methodological differences are assigned to incorrect census occupational categories.

Table B. Operations and Computer Specialists by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	263	100.0	(X)	112	100.0	(X)	151	100.0	(X)
Errors, total	82	31.2	2.9	30	26.8	4.2	52	34.4	3.9
Census coding errors	75	28.5	2.8	25	22.3	3.9	50	33.1	3.8
PMS coding errors[1]	7	2.7	0.9	5	4.5	1.9	2	1.3	0.9
Response causes, total	123	46.8	3.1	49	43.8	4.7	74	49.0	4.1
Conflicting responses	72	27.4	2.7	25	22.3	3.9	47	31.1	3.8
Census insufficient responses	49	18.6	2.4	24	21.4	3.9	25	16.6	3.0
PMS insufficient responses	2	0.8	0.5	-	-	-	2	1.3	0.9
Structural differences, total	37	14.1	2.1	21	18.8	3.7	16	10.6	2.5
PMS subcategory misclassifications	23	8.7	1.7	14	12.5	3.1	9	6.0	1.9
PMS residual-category classifications	14	5.3	1.4	7	6.3	2.3	7	4.6	1.7
Methodological differences, total	21	8.0	1.6	12	10.7	2.9	9	6.0	1.9
Managerial concept	12	4.6	1.3	12	10.7	2.9	(X)	(X)	(X)
Other	9	3.4	1.1	-	-	-	9	6.0	1.9

[1] Includes processing errors.

One of the most common census occupational misclassifications occurred when persons reported their occupation in the census to be "systems analyst," but did not indicate any type of specialty, e.g., "computer systems analyst," "business systems analyst." These persons were assigned to the census occupational category "operations and systems researchers and analysts." The information on their PMS form, however, indicates that the proper occupation for the vast majority is "computer systems analysts." A partial solution for this particular kind of census insufficient response may be the use of industry requirements in the coding process. For example, a respondent could be classified as a "computer systems analyst" if the written entry is "systems analyst" and the industry code is 189 ("manufacturing, electronic computing equipment") or 739 ("computer programming services"). Another possible solution is to add the occupational title, "systems analyst, n.s.," to the occupational category, "computer systems analysts." Of course, this addition could mean that some persons who legitimately belong to the category "operations and systems researchers and analysts" would be misclassified.

Another common census occupational misclassification occurred when the coders incorrectly assigned the written entry "computer programming manager" to the occupational category "computer programmers" instead of to the category "computer systems analysts." Although coding instructions in the 1970 census specified that "manager" was a keyword in assigning correct occupation codes, this rule should receive more emphasis in the future.

At the other end of the C-scale are those mismatches for which the census occupational code assignments are correct. For mismatches involving structural differences (PMS subcategory misclassifications and PMS residual-category classifications), PMS coding errors, PMS insufficient responses, and managerial-concept methodological differences, the assumption of correct census occupational categorizations can be made. These cases comprise about 22 percent of the operations and computer specialist mismatches.

Finally, about 27 percent of the operations and computer specialists mismatches are caused by conflicting responses. There is no way to judge, using the PMS information, whether the occupational category assigned in the census is correct for these cases.

When the sample is divided into major-group level and detailed-level mismatches, there are some differences in their respective C-scale patterns. Major-group level mismatches are more likely to be correctly categorized in the census than are detailed-level mismatches. In fact, only 13 percent of the mismatches at the detailed level are correctly categorized in the census, compared with 34 percent of the cases at the major-group level.

ENGINEERS

About 60 percent of the mismatches for engineers stem from classification-system causes (errors, structural differences, and methodological differences) and about 40 percent from response problems (table C). The classification-system causes are divided between errors—mostly census coding errors—and systemic differences. About two-thirds of the response causes involve conflicting responses; the remaining one-third involve census insufficient responses. PMS insufficient responses are a very minor problem for the engineering group.

In terms of the C-scale, about 36 percent of all engineer mismatches are correctly classified in the census. About two-thirds of these correctly categorized cases involve structural differences. At the major-group level, managerial-concept methodological differences and structural differences are responsible for similar proportions of the correctly classified cases. Interestingly, the subcategory, managerial-concept methodological differences, contains a higher proportion of mismatches at the major-group level for engineers than it does for any other occupational group.

At the other end of the C-scale, about 38 percent of all engineer mismatches were placed into an incorrect occupational category in the census, with census coding errors being the major reason for census misclassification. In most of the cases containing census coding errors, the respondent described one specific engineering occupation but was coded to another specific engineering occupation. For example, in one case the respondent provided the written description "mechanical engineer" in census questions 34a-c, but was given the code for the occupation "civil engineers." This problem illustrates that non-systematic coding error is a major problem in some census occupation groups. Only a stringent quality control system can minimize such errors.

Another type of census occupational misclassification involves respondents who report their occupations to be "design engineer" on the census. In these cases a specific engineering occupation, such as "civil engineers," was assigned according to the industry reported in questions 33 a-c. In other words, two persons who supplied the same occupational description, "design engineer," could have been coded to different detailed categories if they reported different industries on the census. Although this study did not determine how many persons are correctly classified using this criteria, there seems to be evidence that a sufficient number of persons are misclassified to warrant further research in this area.

Finally, conflicting responses are responsible for about 27 percent of the mismatches in the total sample. Conflicting responses are present in this same proportion (about 27 percent) at the major-group and detailed levels. A common conflicting response is that of persons who reported "sales engineer" in the census, and "salesman" or a specific engineering occupation, such as, "mechanical engineer," in the PMS. As is stated in an earlier section, the PMS information is of little use in determining the accuracy of the census occupational categorizations for these cases.

MATHEMATICAL SPECIALISTS

Classification-system causes account for about 64 percent[9] of all mismatch cases for the mathematical specialists, whereas response problems are present in only about 36 percent[9] of the cases (table D). Errors are the major type of classification-system

[9] These percentages are based on 140 cases. The 144 cases shown in table D contain four cases incorrectly included among the mismatches.

Table C. Engineers by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	275	100.0	(X)	112	100.0	(X)	163	100.0	(X)
Errors, total	76	27.6	2.7	30	26.8	4.3	46	28.2	3.5
Census coding errors	69	25.1	2.6	23	20.5	3.8	46	28.2	3.5
PMS coding errors[1]	7	2.5	0.9	7	6.3	2.3	-	-	-
Response causes, total	106	38.5	2.9	34	30.4	4.3	72	44.2	3.9
Conflicting responses	73	26.5	2.6	29	25.9	4.1	44	27.0	3.5
Census insufficient responses	32	11.6	1.9	5	4.5	2.0	27	16.6	2.4
PMS insufficient responses	1	0.4	0.4	-	-	-	1	0.6	0.6
Structural differences, total	65	23.6	2.5	20	17.9	3.6	45	27.6	3.5
PMS subcategory misclassifications	39	14.2	2.1	7	6.3	2.3	32	19.6	3.1
PMS residual-category classifications	26	9.5	1.8	13	11.6	3.0	13	8.0	2.1
Methodological differences, total	28	10.2	1.8	28	25.0	4.1	-	-	-
Managerial concept	25	9.1	1.7	25	22.3	3.9	(X)	(X)	(X)
Other	3	1.1	0.5	3	2.7	1.5	-	-	-

[1]Includes processing errors.

Table D. Mathematical Specialists by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches[2]		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	[1]144	100.0	(X)	[1]115	100.0	(X)	[2]29	100.0	(X)
Errors, total	75	52.1	4.2	63	54.8	4.6	12	41.4	(X)
Census coding errors	41	28.5	3.8	30	26.1	4.1	11	37.9	(X)
PMS coding errors[3]	34	23.6	3.5	33	28.7	4.2	1	3.4	(X)
Response causes, total	50	34.7	4.0	38	33.0	4.4	12	41.4	(X)
Conflicting responses	44	30.6	3.8	32	27.8	4.2	12	41.4	(X)
Census insufficient responses	5	3.5	1.5	5	4.3	1.9	-	-	(X)
PMS insufficient responses	1	0.7	0.7	1	0.9	0.9	-	-	(X)
Structural differences, total	5	3.5	1.5	4	3.5	1.7	1	3.4	(X)
PMS subcategory misclassifications	1	0.7	0.7	1	0.9	0.8	-	-	(X)
PMS residual-category classifications	4	2.8	1.4	3	2.6	1.5	1	3.4	(X)
Methodological differences, total	10	6.9	2.1	6	5.2	2.0	4	13.8	(X)
Managerial concept	6	4.2	1.7	6	5.2	2.0	(X)	(X)	(X)
Other	4	2.8	1.4	-	-	-	4	13.8	(X)

[1]Includes 4 cases incorrectly chosen for the sample, not shown separately.
[2]The sample of detailed-level mismatches for mathematical specialists includes the total number of cases (29) in the universe; thus, the figures in this category are not subject to sampling errors, and standard errors do not apply.
[3]Includes processing errors.

cause, with census coding errors being responsible for a slightly larger proportion of errors than are PMS coding errors. The other kinds of classification causes, structural and methodological differences, are only minor reasons for misclassification. Conflicting responses are the most frequent type of response problem (about 9 out of every 10 response problem cases contain conflicting responses).

Interpreting these data in light of the C-scale reveals that it is likely that about 32 percent of the mathematical specialists mismatched cases are correctly classified in the census. The majority of the correctly classified cases contain PMS coding errors. One of the most common PMS coding errors occurred at the major-group level when college or university professors of mathematics classified themselves to "college or university teachers, excluding science or engineering," instead of to "mathematicians," "statisticians," or "actuaries."

A similar proportion (about 35 percent) of mismatches are incorrectly classified in the census. Census coding errors are at the base of most of the misclassifications. One of the more widespread census coding errors involved clerical workers, such as mathematical clerks, who were classified as "mathematical specialists." Misclassifications of mathematical specialists caused by insufficient census responses are often closer to being correct than are the same kind of misclassifications of other occupational groups. The insufficient responses for the mathematical specialists frequently contain the words "statistical" or "mathematical." Such words usually narrow the possible occupational categorizations to a choice between a particular professional mathematical specialist occupation (such as "statistician") and the occupation "statistical clerk." Insufficient responses of other occupational groups often permit a greater number of choices among possible categorizations.

In the middle of the C-scale are the conflicting responses (about 30 percent of all mismatches.) Proportionately, these cases are more frequent at the detailed level than at the major-group level. Although a limited amount can be said about the correctness of conflicting response cases, there is one suggestion that may alleviate one kind of conflicting response problem. The title "mathematical actuary," which is included under "mathematicians" in the **1970 Classified Index**, perhaps should be moved to the occupation "actuaries." There seems from this investigation to be no real difference between the title "mathematical actuary" and the title "actuary."

Finally, two important facts distinguish the mathematical specialists from other occupational groups. First, standard errors are not applicable at the detailed level since all cases in the universe were examined. Second, PMS List C does not provide a residual category for the mathematical specialists. Thus, structural differences are a very minor problem for this occupation group.

LIFE SCIENTISTS

For life scientists (table E) most of the mismatches are the result of classification-system causes (about 70 percent) rather than the result of response problems (30 percent). Among the various categories of classification-system causes, errors (about 31 percent) and structural differences (about 35 percent) account for similar proportions of the total mismatched cases. About two-thirds of the response problems for this group are conflicting responses; only about one-third are census or PMS insufficient responses.

Analyzing the data from table E in terms of the C-scale shows that about 56 percent of the mismatches are placed in correct census occupations. Structural differences are the most important element in the correctly classified cases, representing about 60 percent of these cases.

A common structural difference concerned persons who reported their PMS occupational title to be "wildlife biologist" or "fishery biologist." In these cases, the respondents would code themselves on the PMS to "biological scientists," even though their occupation titles were subcategories of "agricultural scientists" according to the census. Although the census correctly classified these people according to its 1970 occupational scheme, a question does arise whether it placed persons who reported certain occupational titles, such as "wildlife biologist," into an occupational category that best reflects the kind of work they were doing. One possible way to solve this problem is to switch some of the occupational titles, such as "wildlife biologist," "fishery biologist," and "plant pathologist", from "agricultural scientists" to "biological scientists." These changes may make the titles under both of these occupations more homogeneous. It is not known, however, what effect this change would have on the match cases.[10]

At the other end of the C-scale are mismatches for which the census occupational code assignments are incorrect. For the mismatches involving census coding errors, census insufficient responses, or other methodological differences, there is little doubt that they are misclassified in the census. These cases make up about 24 percent of the mismatches for life scientists.

One of the most frequent census coding errors for this group involves persons who reported their occupation to be either "wildlife biologist" or "fishery biologist" on the census, and were given the code for "biological scientists" instead of the one for "agricultural scientists." It is not possible to determine why the coders made this error. The coders may have assumed that these titles belonged to the occupation "biological scientists," or the errors may have been caused by chance oversights.

Finally, about 20 percent of the life scientists mismatches arise from conflicting responses. Conflicting responses were present in the same proportions (about 20 percent) at the major-group and detailed levels.

PHYSICAL SCIENTISTS

Classification-system causes (about 64 percent) are more prevalent than response problems (about 36 percent) for the total sample of physical scientists (table F). Of the three types of classification-system causes, structural differences are the most common, followed by errors, and then by methodological differences. When the sample is divided into major-group and detailed-level cases, their respective distributions by the causes

[10] That is, cases in which the respondent reported one of the occupational titles such as "wildlife biologist," on the PMS and entered the code for "agricultural scientists."

Table E. Life Scientists by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	185	100.0	(X)	114	100.0	(X)	71	100.0	(X)
Errors, total	57	30.8	3.4	42	36.8	4.5	15	21.1	4.8
Census coding errors	33	17.8	2.8	21	18.4	3.6	12	16.9	4.4
PMS coding errors[1]	24	13.0	2.5	21	18.4	3.6	3	4.2	2.4
Response causes, total	53	28.6	3.3	36	31.6	4.3	17	23.9	5.1
Conflicting responses	36	19.5	2.9	24	21.1	3.8	12	16.9	4.4
Census insufficient responses	11	5.9	1.7	6	5.3	2.1	5	7.0	3.0
PMS insufficient responses	6	3.2	1.3	6	5.3	2.1	-	-	-
Structural differences, total	64	34.6	3.5	25	21.9	3.9	39	54.9	5.9
PMS subcategory misclassifications	18	9.7	2.2	18	15.8	3.4	-	-	-
PMS residual-category classifications	46	24.9	3.2	7	6.1	2.2	39	54.9	5.9
Methodological differences, total	11	5.9	1.7	11	9.6	2.8	-	-	-
Managerial concept	10	5.4	1.6	10	8.8	2.6	(X)	(X)	(X)
Other	1	0.5	0.4	1	0.9	0.8	-	-	-

[1]Includes processing errors.

Table F. Physical Scientists by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	211	100.0	(X)	121	100.0	(X)	90	100.0	(X)
Errors, total	49	23.2	2.9	38	31.4	4.2	11	12.2	3.4
Census coding errors	25	11.8	2.2	18	14.9	3.2	7	7.8	2.8
PMS coding errors[1]	24	11.4	2.2	20	16.5	3.4	4	4.4	2.1
Response causes, total	76	36.0	3.3	54	44.6	4.5	22	24.4	4.5
Conflicting responses	65	30.8	3.2	45	37.2	4.4	20	22.2	4.4
Census insufficient responses	8	3.8	1.3	7	5.8	2.1	1	1.1	1.1
PMS insufficient responses	3	1.4	0.8	2	1.7	1.2	1	1.1	1.1
Structural differences, total	73	34.6	3.3	16	13.2	3.1	57	63.3	5.1
PMS subcategory misclassifications	35	16.6	2.5	8	6.6	2.2	27	30.0	4.8
PMS residual-category classifications	38	18.0	2.6	8	6.6	2.2	30	33.3	5.0
Methodological differences, total	13	6.2	1.6	13	10.7	2.8	-	-	-
Managerial concept	11	5.2	1.5	11	9.1	2.6	(X)	(X)	(X)
Other	2	0.9	0.5	2	1.7	1.1	-	-	-

[1]Includes processing errors.

of mismatch differ in some ways from the one for the total sample. For example, at the detailed level proportionally more cases contain classification-system causes than do cases in the sample as a whole. Furthermore, structural differences are much more frequent at the detailed level than at the major-group level, whereas clerical errors are more widespread at the major-group level than at the detailed level.

In terms of the C-scale, it is likely that about one-half (about 53 percent) of the mismatches are assigned correct census occupations. The largest group of these correctly classified cases involves structural differences (PMS residual-category classifications and PMS subcategory misclassification). The following are examples of the most common cases with structural differences: (1) persons who reported their PMS occupation to be "astronomers" but placed themselves in the PMS residual category, "other natural scientists" instead of the proper category, "physicists"; (2) respondents who stated on the PMS that they were "meteorologists" and incorrectly coded themselves to "earth and marine scientists" instead of to "other natural scientists".

The other end of the C-scale shows that only about 17 percent of the mismatches are misclassified in the census. The remaining 31 percent of the cases have conflicting census and PMS occupations, which prevents any assignment of census correctness. A frequent conflicting response concerns persons who reported the occupational title "metallurgist" on the census and "metallurgical engineer" on the PMS.

SOCIAL SCIENTISTS

Among the entire sample of social scientists (table G), classification-system causes are responsible for about 70 percent of the mismatches and response problems for about 30 percent. Although this same basic split is present at the major-group and detailed levels, there are differences among the various kinds of classification-system causes at each of these levels. For instance, structural differences occur more often at the detailed level (about 53 percent) than at the major-group level (about 22 percent), whereas errors are a greater problem at the major-group level (about 38 percent) than at the detailed level (about 13 percent).

In terms of the C-scale, it is fairly certain that about 58 percent of the social scientists mismatches are placed in correct census occupations. As was true for most of the other occupational groups, structural differences are the largest component of the correctly classified cases. The two most typical cases involving structural differences are: (1) persons who reported "financial analyst" in the PMS and coded themselves to "accountants" rather than to "economists"; (2) persons who described their PMS occupational title as "psychiatric social worker" and placed themselves in the occupation "other social scientist" instead of in "other occupations." Although in both these examples these persons are correctly classified in the census according to the 1970 classification system, there is considerable evidence from the PMS that the occupational title "financial analyst" should be moved from the occupational category "economists" to that of "accountants." Also, there is some support from the PMS for placing the occupational title "psychiatric social worker" under "psychologists" rather than under "social workers." Both of these changes may reflect more realistic occupational categories for these occupation titles.

In terms of the C-scale, about 26 percent of the mismatches are incorrectly classified in the census, with census coding errors causing the largest proportion of the misclassifications. A common census misclassification concerns persons who reported their occupational title to be "marketing representative" and were incorrectly coded to the occupational category "economists." It should be mentioned that the occupational title, "marketing representative" does not appear in either the 1970 **Alphabetical** or **Classified Indexes.**

Finally, about 16 percent of the mismatches contain conflicting responses. An interesting form of conflicting response occurs among a few respondents who identified themselves as being "psychologists" in the PMS but "physiologists" in the census. Almost certainly their intended census entry of the word "psychologist" was misspelled as "physiologists." Most likely, they were enumerated in one of the field followups conducted during the census operations, and for some reason, their occupational information was incorrectly recorded by clerical personnel.

GRAPHIC ANALYSIS

Figures 1, 2, and 3 summarize the results of the PMS-Census Match in the form of bar charts. Figure 1 distributes the mismatches in each occupational group according to the categories of the C-scale. Figure 2 distributes the correctly categorized areas of figure 1 according to mismatch causes, and figure 3 does the same thing for the incorrectly categorized areas of figure 1.

Table G. Social Scientists by Causes of Mismatches Between Census and PMS Occupational Classifications, by Level of Mismatch

(For meaning of symbols, see text)

Causes of mismatch	Mismatched cases								
	Total			Major-group level mismatches			Detailed-level mismatches		
	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent	Number	Percent	Standard error of percent
All causes, total	184	100.0	(X)	122	100.0	(X)	62	100.0	(X)
Errors, total	54	29.3	3.3	46	37.7	4.4	8	12.9	4.3
Census coding errors	30	16.3	2.7	23	18.9	3.5	7	11.3	4.0
PMS coding errors[1]	24	13.0	2.5	23	18.9	3.5	1	1.6	1.6
Response causes, total	57	31.0	3.4	37	30.3	4.2	20	32.3	5.9
Conflicting responses	29	15.8	2.7	19	15.6	3.3	10	16.1	4.7
Census insufficient responses	16	8.7	2.1	9	7.4	2.4	7	11.3	4.0
PMS insufficient responses	12	6.5	1.8	9	7.4	2.4	3	4.8	2.7
Structural differences, total	60	32.6	3.4	27	22.1	3.8	33	53.2	6.3
PMS subcategory misclassifications	49	26.6	3.3	23	18.9	3.5	26	41.9	6.3
PMS residual-category classifications	11	6.0	1.7	4	3.3	1.6	7	11.3	4.0
Methodological differences, total	13	7.1	1.9	12	9.8	2.7	1	1.6	1.6
Managerial concept	11	6.0	1.7	11	9.0	2.6	(X)	(X)	(X)
Other	2	1.1	0.7	1	0.8	0.8	1	1.6	1.6

[1]Includes processing errors.

Figure 1

Major 1970 Census Occupational Groups, by C-scale Categories

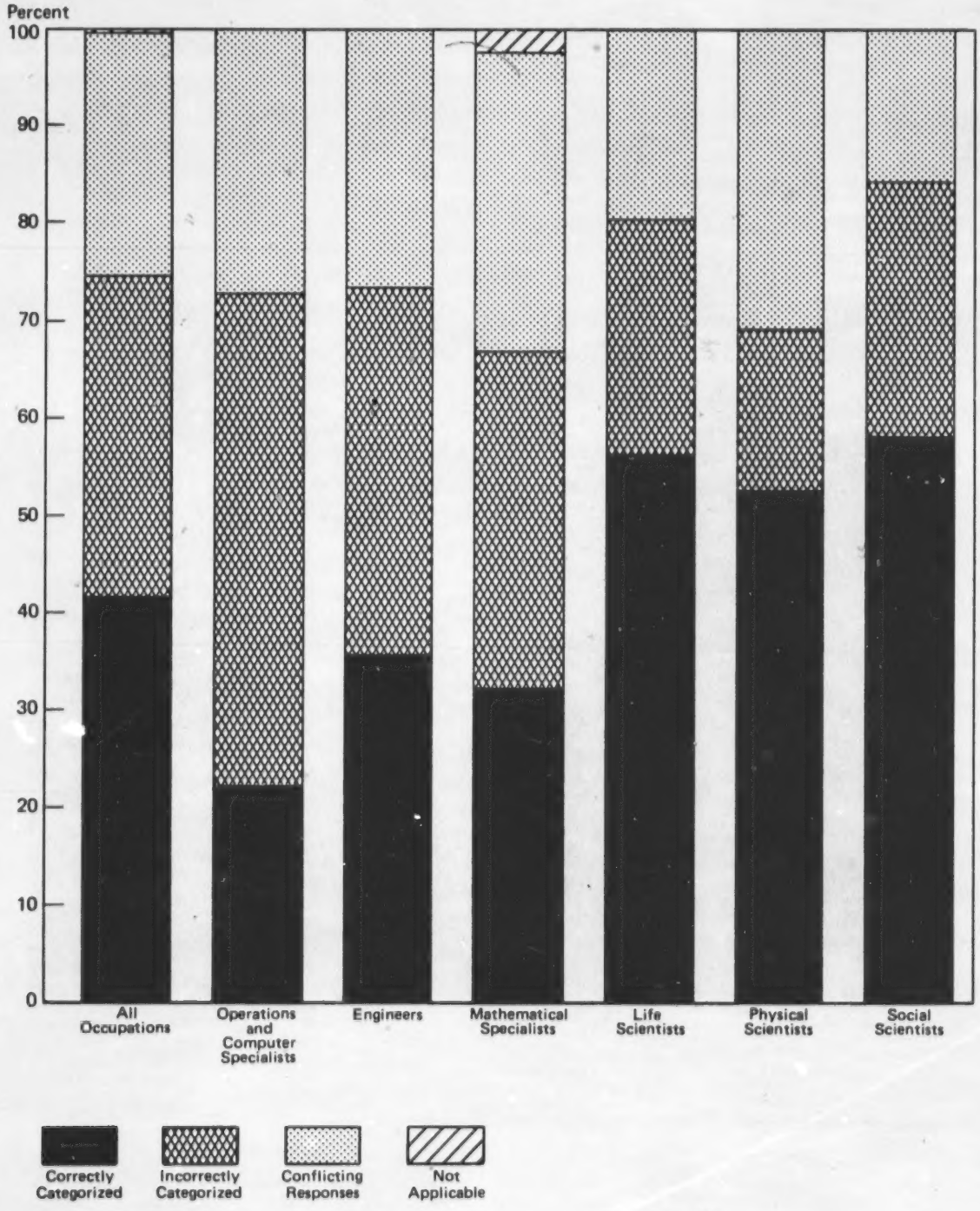


Figure 2

Correctly Categorized Mismatches (According to the C-scale), by Major 1970 Census Occupational Groups, by Causes of Mismatches

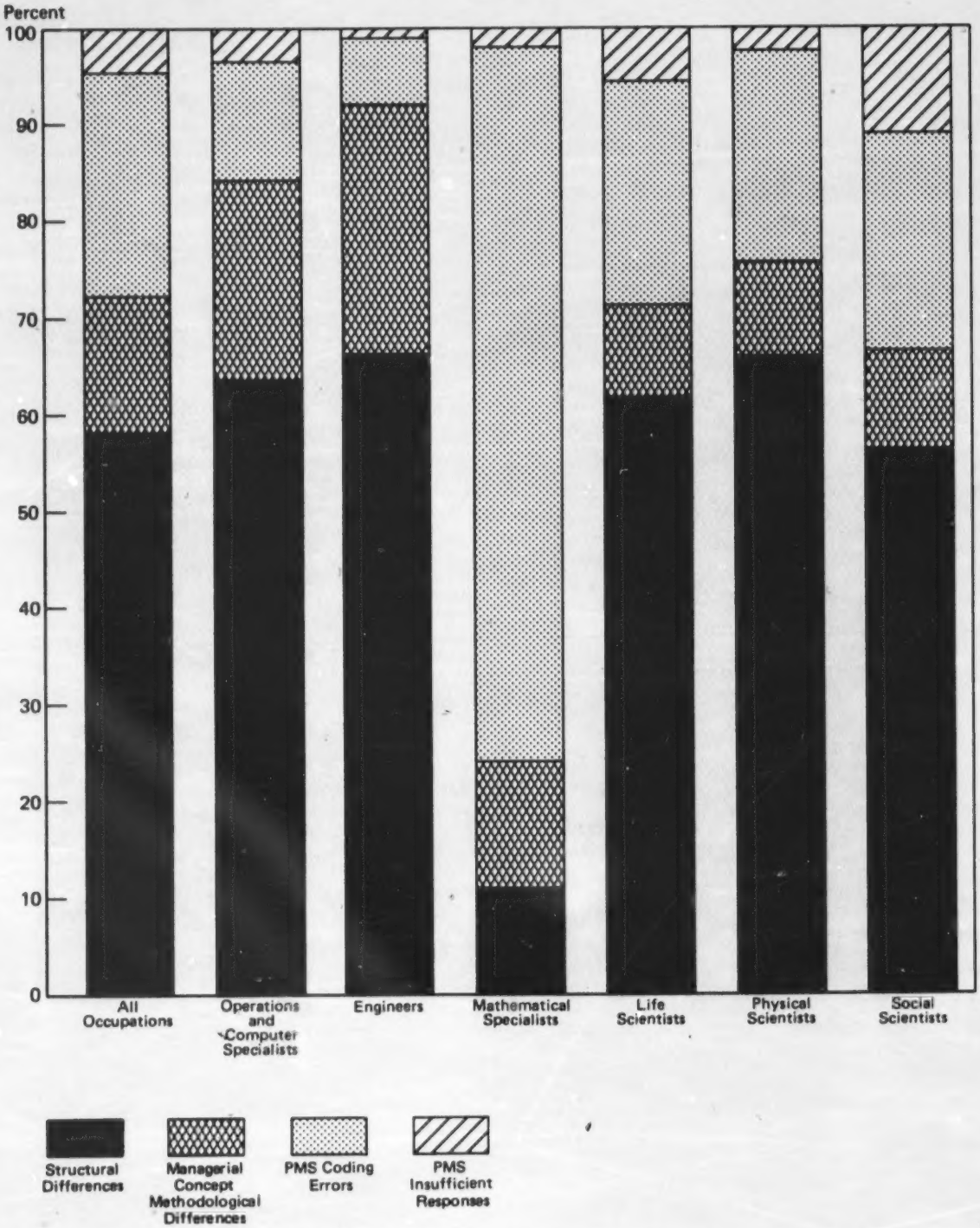


Figure 3

Incorrectly Categorized Mismatches (According to the C-scale), by Major 1970 Census Occupational Groups, by Causes of Mismatches

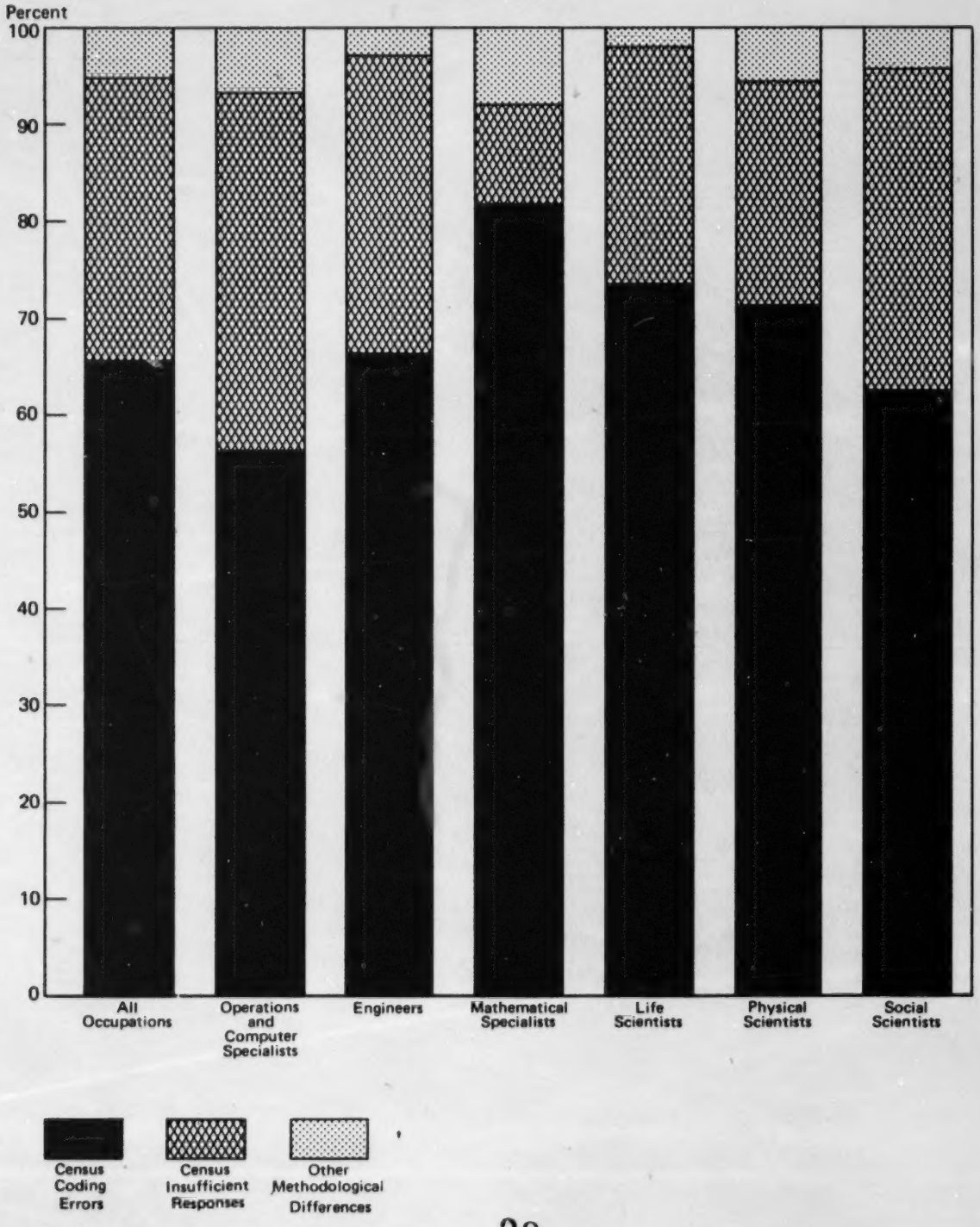


Table 1. DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1970 CENSUS, BY DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1972 POSTCENSAL MANPOWER SURVEY, FOR RESPONDENTS IN THE 1972 POSTCENSAL MANPOWER SURVEY

Detailed 1970 census occupation	Detailed Postcensal Manpower Survey (PMS) occupation in 1970														
		With 1970 PMS occupation reported													
			Computer specialists					Operations Research analysts	Engineers						
	Total	Total	Total	Computer programmers	Computer systems analysts	Computer scientists	Other computer specialists		Total	Aeronautical and astronautical	Agricultural	Chemical	Civil and architectural	Electrical and electronic	Industrial
Total	40,887	34,938	4,182	1,331	1,807	157	887	300	11,529	893	53	1,047	1,254	1,935	809
Operations and computer specialists	6,960	5,979	3,774	1,256	1,684	97	737	109	303	26	3	8	8	73	68
Computer programmers	2,123	1,854	1,654	1,027	362	31	234	3	24	3	-	-	2	5	-
Computer systems analysts	2,172	1,865	1,458	160	943	35	320	25	54	4	-	3	3	24	5
Computer specialists, n.e.c.	467	398	238	31	73	27	107	3	51	7	-	-	1	19	3
Operations and systems researchers and analysts	2,198	1,862	424	38	306	4	76	78	174	12	3	5	2	25	60
Engineers	18,606	15,909	196	33	67	19	77	63	10,716	837	42	992	1,219	1,773	732
Aeronautical and astronautical engineers	2,154	1,852	31	8	15	2	6	16	1,413	659	-	5	11	149	29
Chemical engineers	2,048	1,822	18	2	9	2	5	4	1,317	4	5	872	11	26	11
Civil engineers	2,333	2,014	9	5	2	1	1	2	1,463	23	7	12	1,051	14	10
Electrical and electronic engineers	2,549	2,177	56	5	19	9	23	4	1,591	22	1	4	13	1,176	19
Industrial engineers	2,207	1,882	16	2	6	2	6	15	1,050	12	-	10	7	63	533
Mechanical engineers	2,259	1,925	11	3	1	1	6	7	1,440	43	5	8	15	53	41
Metallurgical and materials engineers	590	516	3	1	1	-	1	1	400	2	-	8	11	10	13
Mining engineers	178	144	-	-	-	-	-	-	85	-	-	-	3	1	-
Petroleum engineers	377	338	3	-	2	-	1	5	261	-	-	11	5	7	1
Sales engineers	1,933	1,595	10	-	1	-	9	1	633	9	2	16	7	91	23
Engineers, n.e.c.	1,789	1,475	39	7	11	2	19	8	942	58	13	31	66	156	48
Engineering teachers*	189	169	-	-	-	-	-	-	121	5	9	15	19	25	4
Mathematical specialists	2,178	1,868	115	27	35	28	25	58	36	5	-	-	-	3	-
Actuaries	189	170	2	1	-	-	1	2	2	1	-	-	-	-	-
Mathematicians	275	237	52	12	21	10	9	23	10	2	-	-	-	1	-
Statisticians	784	663	17	4	7	1	5	32	16	2	-	-	-	1	-
Mathematics teachers*	930	798	44	10	7	17	10	1	8	-	-	-	-	1	-
Life scientists	3,215	2,775	7	3	2	1	1	4	20	-	6	-	5	1	1
Agricultural scientists	476	400	1	-	-	-	1	1	7	-	2	-	4	-	1
Agriculture teachers*	173	147	-	-	-	-	-	-	5	-	3	-	1	-	-
Biological scientists	1,100	952	4	1	2	1	-	3	3	-	-	-	-	-	-
Biology teachers*	794	673	1	1	-	-	-	-	1	-	-	-	-	1	-
Foresters and conservationists[1]	672	603	1	1	-	-	-	-	4	-	1	-	-	-	-
Physical scientists	5,104	4,392	41	9	8	11	13	16	392	23	2	44	11	75	4
Atmospheric and space scientists	226	198	2	2	-	-	-	2	8	4	-	-	-	1	-
Atmospheric, earth, marine, and space teachers*	185	158	-	-	-	-	-	-	3	1	-	-	-	-	-
Geologists	769	645	9	2	2	3	2	1	29	-	-	-	3	2	-
Marine scientists	134	114	1	-	-	1	-	1	17	-	1	-	8	1	-
Chemists	2,039	1,795	12	2	4	1	5	3	160	1	1	40	-	2	2
Chemistry teachers*	302	250	-	-	-	-	-	-	2	-	-	1	-	-	-
Physicists and astronomers	850	729	15	2	2	6	5	7	121	15	-	1	-	36	1
Physics teachers*	548	460	1	1	-	-	-	-	41	2	-	1	-	30	-
Life and physical scientists, n.e.c.	51	43	1	-	-	-	1	2	11	-	-	1	-	3	1
Social scientists	4,824	4,015	49	3	11	1	34	50	62	2	-	3	11	10	4
Economists	1,843	1,522	46	2	11	1	32	48	39	2	-	2	2	9	4
Economics teachers*	298	256	1	-	-	-	1	-	1	-	-	-	1	-	-
Psychologists	991	814	1	1	-	-	-	-	3	-	-	-	1	-	-
Psychology teachers*	457	377	-	-	-	-	-	-	-	-	-	-	-	-	-
Sociologists	53	41	-	-	-	-	-	-	-	-	-	-	-	-	-
Sociology teachers*	257	217	-	-	-	-	-	-	-	-	-	-	-	-	-
Political scientists	23	18	-	-	-	-	-	-	-	-	-	-	-	-	-
Urban and regional planners	336	289	-	-	-	-	-	2	18	-	-	1	7	1	-
Social scientists, n.e.c.	118	100	1	-	-	-	1	-	-	-	-	-	-	-	-
Social science teachers, n.e.c.*	448	381	-	-	-	-	-	-	1	-	-	-	-	-	-

n.e.c. Not elsewhere classified.
*College and university.
[1]With 4 or more years of college.

Table 1. DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1970 CENSUS, BY DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1972 POSTCENSAL MANPOWER SURVEY, FOR RESPONDENTS IN THE 1972 POSTCENSAL MANPOWER SURVEY—Continued

Detailed 1970 census occupation	Detailed Postcensal Manpower Survey (PMS) occupation in 1970--Continued														
	With 1970 PMS occupation reported--Continued														
	Engineers--Continued						Mathematicians and statisticians				Life and physical scientists				
	Mechanical	Metallurgical and materials	Mining and petroleum	Nuclear	Environmental and sanitary	Other	Total	Actuaries	Mathematicians	Statisticians	Total	Agricultural scientists[2]	Biological scientists	Biochemists	Chemists
Total	2,110	451	335	96	150	2,396	1,130	137	522	471	4,833	776	664	148	1,214
Operations and computer specialists	22	3	3	3	1	85	50	3	24	23	23	2	4	-	-
Computer programmers	4	-	1	-	-	9	16	2	12	2	11	2	-	-	-
Computer systems analysts	2	1	-	-	-	12	11	-	5	6	7	-	2	-	-
Computer specialists, n.e.c.	5	-	2	2	-	12	2	-	2	-	2	-	-	-	-
Operations and systems researchers and analysts	11	2	-	1	1	52	21	1	5	15	3	-	2	-	-
Engineers	2,068	348	312	62	134	2,197	35	1	11	23	125	10	-	1	68
Aeronautical and astronautical engineers	276	14	-	1	3	266	8	-	4	4	8	-	-	-	3
Chemicals engineers	112	45	15	10	19	187	1	-	1	-	56	3	-	1	47
Civil engineers	46	3	8	2	70	217	-	-	-	-	10	3	-	-	-
Electrical and electronic engineers	80	6	-	25	1	244	3	-	1	2	2	-	-	-	-
Industrial engineers	97	11	7	4	4	300	13	-	-	13	8	-	-	-	6
Mechanical engineers	990	9	8	9	6	253	2	1	-	1	2	-	-	-	-
Metallurgical and materials engineers	46	224	1	4	2	79	1	-	1	-	4	-	-	-	4
Mining engineers	4	2	67	-	-	8	-	-	-	-	7	-	-	-	-
Petroleum engineers	11	1	191	-	-	34	-	-	-	-	5	-	-	-	1
Sales engineers	113	14	8	-	9	341	3	-	1	2	2	2	-	-	-
Engineers, n.e.c.	268	15	4	7	17	259	4	-	3	1	20	2	-	-	7
Engineering teachers*	25	4	3	-	3	9	-	-	-	-	1	-	-	-	-
Mathematical specialists	8	-	-	1	-	19	986	132	475	379	21	1	2	2	5
Actuaries	1	-	-	-	-	-	120	117	2	1	2	-	-	-	1
Mathematicians	2	-	-	-	-	5	104	10	84	10	4	-	-	1	3
Statisticians	2	-	-	1	-	10	346	4	2	340	6	1	-	1	1
Mathematics teachers*	3	-	-	-	-	4	416	1	387	28	9	-	2	-	-
Life scientists	-	2	-	-	1	4	4	-	-	4	1,724	743	632	25	18
Agricultural scientists	-	-	-	-	-	-	3	-	-	3	207	145	36	2	1
Agriculture teachers*	-	-	-	-	-	1	-	-	-	-	78	71	3	-	-
Biological scientists	-	2	-	-	1	-	1	-	-	1	526	63	254	18	12
Biology teachers*	-	-	-	-	-	-	-	-	-	-	452	15	337	5	3
Foresters and conservationists[1]	-	-	-	-	-	3	-	-	-	-	461	447	2	-	2
Physical scientists	6	98	20	30	14	65	12	-	10	2	2,883	9	20	118	1,117
Atmospheric and space scientists	-	-	1	-	-	2	1	-	1	-	99	-	-	-	4
Atmospheric, earth, marine, and space teachers*	-	1	-	-	-	1	-	-	-	-	109	-	1	-	-
Geologists	-	-	19	-	1	4	1	-	1	-	529	1	-	-	3
Marine scientists	-	-	-	-	2	5	-	-	-	-	68	-	2	1	1
Chemists	2	91	-	4	5	12	2	-	-	2	1,123	7	10	88	958
Chemistry teachers*	-	-	-	-	-	1	1	-	1	-	177	1	-	29	142
Physicists and astronomers	2	5	-	22	4	35	1	-	1	-	465	-	2	-	8
Physics teachers*	2	-	-	2	-	4	4	-	4	-	306	-	3	-	1
Life and physical scientists, n.e.c.	-	1	-	2	2	1	2	-	2	-	7	-	2	-	-
Social scientists	6	-	-	-	-	26	43	1	2	40	57	11	6	2	6
Economists	4	-	-	-	-	16	36	1	-	35	12	5	1	-	1
Economics teachers*	-	-	-	-	-	-	-	-	-	-	3	1	1	-	-
Psychologists	-	-	-	-	-	2	1	-	-	1	13	-	-	2	-
Psychology teachers*	-	-	-	-	-	-	2	-	-	2	8	1	3	-	-
Sociologists	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Sociology teachers*	-	-	-	-	-	-	2	-	2	-	1	1	-	-	-
Political scientists	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urban and regional planners	2	-	-	-	-	7	1	-	-	1	2	-	-	-	1
Social scientists, n.e.c.	-	-	-	-	-	-	1	-	-	1	9	2	-	-	1
Social science teachers, n.e.c.*	-	-	-	-	-	1	-	-	-	-	6	1	1	-	1

Table 1. DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1970 CENSUS, BY DETAILED OCCUPATION IN 1970 ACCORDING TO THE 1972 POSTCENSAL MANPOWER SURVEY, FOR RESPONDENTS IN THE 1972 POSTCENSAL MANPOWER SURVEY—Continued

Detailed 1970 census occupation	Detailed Postcensal Manpower Survey (PMS) occupation in 1970--Continued														
	With 1970 PMS occupation reported--Continued										1970 PMS occupation not reported				
	Life and physical scientists--Continued				Social scientists					All other occupations					
	Earth and marine scientists	Medical scientists	Physicists	Other life and physical scientists	Total	Economists	Psychologists	Sociologists and anthropologists	Other social scientists		Total	Employment status not specified	Unemployed	Out of labor force	Labor force status not available
Total	806	248	741	236	1,659	399	795	202	263	11,304	5,949	235	65	163	5,486
perations and computer specialists	8	3	5	1	23	9	1	1	12	1,697	981	35	16	18	912
Computer programmers	4	2	3	-	2	1	1	-	-	144	269	5	5	3	256
Computer systems analysts	2	-	2	1	4	4	-	-	-	306	307	11	6	3	287
Computer specialists, n.e.c.	1	1	-	-	-	-	-	-	-	102	69	1	-	5	63
Operations and systems researchers and analysts	1	-	-	-	17	4	-	1	12	1,145	336	18	5	7	306
ngineers	21	1	16	8	17	6	6	1	4	4,757	2,697	100	35	21	2,541
Aeronautical and astronautical engineers	1	-	3	1	1	-	1	-	-	375	302	18	6	1	277
Chemical engineers	1	-	2	2	3	2	1	-	-	423	226	7	5	4	210
Civil engineers	7	-	-	-	2	1	-	-	1	528	319	14	1	2	302
Electrical and electronic engineers	-	-	2	-	-	-	-	-	-	521	372	13	4	3	352
Industrial engineers	1	-	-	1	5	2	2	-	1	775	325	14	5	2	304
Mechanical engineers	-	1	1	-	1	-	-	-	1	462	334	4	2	1	327
Metallurgical and materials engineers	-	-	-	-	-	-	-	-	-	107	74	2	-	-	72
Mining engineers	7	-	-	-	1	-	-	1	-	51	34	1	-	-	33
Petroleum engineers	2	-	2	-	-	-	-	-	-	64	39	3	-	-	36
Sales engineers	-	-	-	-	1	1	-	-	-	945	338	11	3	2	322
Engineers, n.e.c.	2	-	5	4	2	-	2	-	-	460	314	13	8	4	289
Engineering teachers*	-	-	1	-	1	-	-	-	1	46	20	-	1	2	17
thematical specialists	1	3	4	3	28	9	3	5	11	623	310	25	3	17	265
Actuaries	-	-	-	1	-	-	-	-	-	42	19	1	-	-	18
Mathematicians	-	-	-	-	-	-	-	-	-	44	38	2	-	2	34
Statisticians	-	2	-	1	20	8	-	2	10	225	121	9	-	2	110
Mathematics teachers*	1	1	4	1	8	1	3	3	1	312	132	13	3	13	103
ife scientists	26	184	3	93	36	6	20	3	7	980	440	18	3	25	394
Agricultural scientists	6	1	-	16	3	2	-	-	1	178	76	1	1	-	74
Agriculture teachers*	1	-	-	1	5	3	-	-	2	59	26	2	-	2	22
Biological scientists	14	114	2	49	20	-	17	-	3	395	148	6	1	5	136
Biology teachers*	1	68	1	22	7	-	3	3	1	212	121	7	-	14	100
Foresters and conservationists[1]	4	1	-	5	1	1	-	-	-	136	69	2	1	4	62
ysical scientists	747	17	712	123	9	3	-	-	6	1,039	712	27	2	33	650
Atmospheric and space scientists	51	-	6	38	-	-	-	-	-	86	28	2	-	-	26
Atmospheric, earth, marine, and space teachers*	103	-	-	5	3	-	-	-	3	43	27	2	-	6	19
Geologists	515	1	3	6	-	-	-	-	-	76	124	7	-	2	115
Marine scientists	55	-	2	7	-	-	-	-	-	27	20	-	-	1	19
Chemists	9	19	4	28	5	3	-	-	2	490	244	11	1	9	223
Chemistry teachers*	-	3	1	1	-	-	-	-	-	70	52	2	-	5	45
Physicists and astronomers	10	12	410	23	-	-	-	-	-	120	121	3	-	3	115
Physics teachers*	2	1	285	14	1	-	-	-	1	107	88	-	1	7	80
Life and physical scientists, n.e.c.	2	1	1	1	-	-	-	-	-	20	8	-	-	-	8
cial scientists	3	20	1	8	1,546	366	765	192	223	2,208	809	30	6	49	724
Economists	1	2	-	-	367	247	1	-	19	1,074	321	11	2	10	298
Economics teachers*	-	1	-	-	117	111	-	2	2	134	42	4	-	2	36
Psychologists	-	9	-	2	624	1	579	7	37	172	177	4	-	15	158
Psychology teachers*	-	4	-	-	189	-	179	1	9	178	80	2	1	8	69
Sociologists	-	1	-	2	26	-	1	22	3	12	12	1	-	-	11
Sociology teachers*	-	-	-	-	119	-	2	111	6	95	40	4	2	7	27
Political scientists	-	-	-	-	6	-	-	-	6	12	5	-	-	1	4
Urban and regional planners	-	-	1	-	41	2	-	-	39	225	47	1	-	1	45
Social scientists, n.e.c.	2	1	-	3	32	2	-	12	18	57	18	-	1	2	15
Social science teachers, n.e.c.*	-	2	-	1	125	1	3	17	84	249	67	3	-	3	61

Table 2. TOTAL CASES WITHIN UNIVERSE OF THE STUDY, BY AGREEMENT BETWEEN CENSUS AND PMS OCCUPATIONAL CLASSIFICATION, BY LEVEL OF DISAGREEMENT FOR MISMATCHED CASES, BY DETAILED CENSUS OCCUPATION IN 1970

Detailed 1970 census occupation	Total		Matches		Mismatched cases					
					Total		Major-group level		Detailed level	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total cases in universe.....	34,938	100.0	15,318	43.8	19,620	56.2	13,187	37.7	6,433	18.4
Operations and computer specialists	5,979	100.0	2,182	36.5	3,797	63.5	2,096	35.1	1,701	28.4
Computer programmers.....	1,854	100.0	1,027	55.4	827	44.6	197	10.6	630	34.0
Computer systems analysts.....	1,865	100.0	943	50.6	922	49.4	382	20.5	540	29.0
Computer specialists, n.e.c.....	398	100.0	134	33.7	264	66.3	157	39.4	107	26.9
Operations and systems researchers and analysts.....	1,862	100.0	78	4.2	1,784	95.8	1,360	73.0	424	22.8
Engineers.....	15,909	100.0	6,665	41.9	9,244	58.1	4,949	31.1	4,295	27.0
Aeronautical and astronautical engineers.....	1,852	100.0	715	38.6	1,137	61.4	383	20.7	754	40.7
Chemical engineers.....	1,822	100.0	872	47.9	950	52.1	495	27.2	455	25.0
Civil engineers.....	2,014	100.0	1,121	55.7	893	44.3	514	25.5	379	18.8
Electrical and electronic engineers.....	2,177	100.0	1,201	55.2	976	44.8	569	26.1	407	18.7
Industrial engineers.....	1,882	100.0	533	28.3	1,349	71.7	828	44.0	521	27.7
Mechanical engineers.....	1,925	100.0	990	51.4	935	48.6	429	22.3	506	26.3
Metallurgical and materials engineers.....	516	100.0	224	43.4	292	56.6	113	21.9	179	34.7
Mining engineers.....	144	100.0	67	46.5	77	53.5	58	40.3	19	13.2
Petroleum engineers.....	338	100.0	191	56.5	147	43.5	76	22.5	71	21.0
Sales engineers.....	1,595	100.0	341	21.4	1,254	78.6	951	59.6	303	19.0
Engineers, n.e.c.....	1,475	100.0	289	19.6	1,186	80.4	485	32.9	701	47.5
Engineering teachers*.....	169	100.0	121	71.6	48	28.4	48	28.4	-	-
Mathematical specialists.....	1,868	100.0	957	51.2	911	48.8	882	47.2	29	15.5
Actuaries.....	170	100.0	117	68.8	53	31.2	50	29.4	3	1.8
Mathematicians.....	237	100.0	84	35.4	153	64.6	133	56.1	20	8.4
Statisticians.....	663	100.0	340	51.3	323	48.7	317	47.8	6	0.9
Mathematics teachers*.....	798	100.0	416	52.1	382	47.9	382	47.9	-	-
Life scientists.....	2,775	100.0	1,438	51.8	1,337	48.2	1,216	43.8	121	4.4
Agriculture scientists.....	400	100.0	145	36.3	255	63.8	218	54.5	37	9.3
Agriculture teachers*.....	147	100.0	73	49.7	74	50.3	71	48.3	3	2.0
Biological scientists.....	952	100.0	368	38.7	584	61.3	521	54.7	63	6.6
Biology teachers*.....	673	100.0	405	60.2	268	39.8	253	37.6	15	2.2
Foresters and conservationists[1]..	603	100.0	447	74.1	156	25.9	153	25.3	3	0.5
Physical scientists.....	4,392	100.0	2,629	59.9	1,763	40.1	1,575	35.9	188	4.3
Atmospheric and space scientists.	198	100.0	38	19.2	160	80.8	99	50.0	61	30.8
Atmospheric, earth, marine, and space teachers*.....	158	100.0	108	68.4	50	31.6	50	31.6	-	-
Geologists.....	645	100.0	515	79.8	130	20.2	118	18.3	12	1.9
Marine scientists.....	114	100.0	55	48.2	59	51.8	48	42.1	11	9.7
Chemists.....	1,795	100.0	1,046	58.3	749	41.7	708	39.4	41	2.3
Chemistry teachers*.....	250	100.0	171	68.4	79	31.6	77	30.8	2	0.8
Physicists and astronomers.....	729	100.0	410	56.2	319	43.8	278	38.1	41	5.6
Physics teachers*.....	460	100.0	285	62.0	175	38.0	158	34.3	17	3.7
Life and physical scientists, n.e.c.....	43	100.0	1	2.3	42	97.7	39	90.7	3	7.0
Social scientists.....	4,015	100.0	1,447	36.0	2,568	64.0	2,469	61.5	99	2.5
Economists.....	1,522	100.0	247	16.2	1,275	83.8	1,255	82.5	20	1.3
Economics teachers*.....	256	100.0	113	44.1	143	55.9	139	54.3	4	15.6
Psychologists.....	814	100.0	579	71.1	235	28.9	190	23.3	45	5.5
Psychology teachers*.....	377	100.0	179	47.5	198	52.5	188	49.9	10	2.7
Sociologists.....	41	100.0	22	53.7	19	46.3	15	36.6	4	9.8
Sociology teachers*.....	217	100.0	111	51.1	106	48.8	98	45.2	8	3.7
Political scientists.....	18	100.0	6	33.3	12	66.7	12	66.7	-	-
Urban and regional planners.....	289	100.0	39	13.5	250	86.5	248	85.8	2	0.7
Social scientists, n.e.c.....	100	100.0	30	30.0	70	70.0	68	68.0	2	2.0
Social science teachers, n.e.c.*.	381	100.0	121	31.8	260	68.2	256	67.2	4	1.0

n.e.c. Not elsewhere classified.
*College and university.
[1]With 4 or more years of college.

TABLE 3. UNIVERSE AND SAMPLE CASES BY MAJOR 1970 CENSUS OCCUPATIONAL GROUP, BY LEVEL OF MISMATCH

Major 1970 census occupation group	Mismatched cases			
	Major-group level		Detailed-group level	
	Total	Sample	Total	Sample
Total, all groups	13,187	696	6,433	571
Operations and computer specialists	2,096	112	1,701	[1]134
Engineers	4,949	112	4,295	[1]164
Mathematical specialists	882	115	29	29
Life scientists	1,216	114	121	71
Physical scientists	1,575	121	188	90
Social scientists	2,469	122	99	[1]63

[1]These numbers differ from those in tables A,B,C, and G because they include cases whose PMS or census questionnaires could not be located.

APPENDIX A

Postcensal Manpower Survey (PMS)

Occupational Coding Scheme: "List C—Occupations"

List C – OCCUPATIONS

This list is to be used in answering the questions about the kind of work you were doing and about your professional or occupational classification. When the instructions for a particular item on the questionnaire request you to enter a code and description from this list, please scan the entire list, then choose the appropriate entry. If you cannot find exactly the right entry, please choose the one that comes nearest to it. If none of the entries is at all appropriate, use the "Other" category (code 469) and enter a brief description in the space provided on the questionnaire.

Code	Description
	Engineers, including college professors and instructors
401	Engineer, aeronautical and astronautical
402	Engineer, agricultural
403	Engineer, chemical
404	Engineer, civil and architectural
405	Engineer, electrical and electronic
406	Engineer, industrial
407	Engineer, mechanical
408	Engineer, metallurgical and materials
409	Engineer, mining and petroleum
410	Engineer, nuclear
411	Engineer, enviromental and sanitary
412	Engineer, other fields *(Describe briefly under the applicable item on the questionnaire.)*
	Computer Specialists, including college professors and instructors
413	Computer programmer
414	Computer systems analyst
415	Computer scientist
416	Other computer specialist *(Describe briefly under the applicable item on the questionnaire.)*
	Mathematicians and Statisticians, including college professors and instructors
417	Actuary
418	Mathematician
419	Statistician
420	Operations research analyst
	Natural Scientists, including college professors and instructors
421	Agricultural scientist, including foresters and conservationists
422	Biological scientist
423	Biochemist
424	Chemist
425	Earth and marine scientist, including geoglogists, geophysicists, oceanographers, etc.
426	Medical scientist, excluding persons who are primarily medical practitioners; see Health Occupations below
427	Physicist
428	Other natural scientist *(Describe briefly under the applicable item on the questionnaire.)*
	Social Scientists, including college professors and instructors
429	Economist
430	Psychologist
431	Sociologist or anthropologist
432	Other social scientist *(Describe briefly under the applicable item on the questionnaire.)*

Code	Description
	Health Occupations, including persons who are primarily practitioners. Persons engaged primarily in medical research, teaching, and similar activities use code 426, Medical scientist.
433	Physician or surgeon
434	Technician, dental
435	Technician, medical
436	Other health occupation *(Describe briefly under the applicable item on the questionnaire.)*
	Technicians and Technologists, except medical
437	Designer, electronic parts and machine tools
438	Designer, industrial
439	Designer, other
440	Draftsman
441	Surveyor
442	Technician, biological and agricultural
443	Technician, electrical and electronic
444	Technician, construction, highways, and architectural
445	Technician, mechanical
446	Technician, other engineering
447	Technician, physical science
448	Technician, other fields *(Describe briefly under the applicable item on the questionnaire.)*
	Teachers
449	Teacher, elementary school
450	Teacher, secondary school
451	Teacher, college and university, excluding engineering and science (Engineering and science teachers see codes 401-432 above.)
	Administrators, Managers, and Officials, excluding farm
452	College president or dean
453	Administrator or manager, scientific and technical research and development
454	Administrator or manager, production and operations
455	Administrator, manager, or official, all other, excluding self-employed
456	Self-employed proprietor
	All Other Occupations
457	Accountant
458	Attorney or judge
459	Clerical or sales worker (such as salesman, bookkeeper, secretary, etc.)
460	Clergyman
461	Craftsman (such as baker, carpenter, electrician, mechanic, repairman, etc.)
462	Farmer (owner, manager, tenant, or farm laborer)
463	Fireman or policeman
464	Laborer, except farm
465	Librarian
466	Merchant or shopkeeper, self-employed
467	Operative (such as assembler, factory worker, miner, welder, truck driver, etc.)
468	Postal worker
469	Other occupations, not specified above *(Describe briefly under the applicable item on the questionnaire.)*

APPENDIX B

Decision-Logic Table for Comparing Postcensal Manpower Survey (PMS) and Census Responses

A response in the Postcensal Manpower Survey consists of (1) written entries in questions 22, 23, and 24, and (2) a code from reference List C (see appendix A) in the code box of question 22. The PMS code, however, is also part of the PMS classification system; and often, it is difficult to determine the extent to which the respondent considered it to be a part of the occupational description, rather than merely a way of classifying this description. It is for this reason that a decision-logic table was created to help translate the PMS response into one that could be compared with the census response. The decision-logic table provided a consistent, scientific method of deciding the weight that should be given to the PMS code as an element of the occupational description; it specified under what conditions the code would be considered entirely as a classification device, and under what conditions it would be considered an integral, and perhaps deciding, piece of occupational description information.

There are two sections in the decision-logic table. The first, consisting of situations 1-7, refers to cases whose written entries on the PMS convey essentially the same information as the census entries. The second section consisting of situations 8-14, refers to the converse cases—those whose PMS written information is different (either consistent or conflicting) from that in the census.

How to use the table is illustrated by the following verbalization of the symbols of "Situation 1" (see the first column of the table). Situation 1 states that if the person's written PMS entry is essentially the same as the census entry, and if the written entry in question 22 indicates that the person belongs in a PMS category other than the one associated with the code entered in the code box of question 22, and if the code entered is 459 or 437-448, then, in spite of the written entries in PMS questions 23 and 24, the PMS code is to be treated as an essential part of the PMS occupational description.

Conditions and Actions	Situations													
Conditions[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14
The written entries in the PMS convey essentially the same information as the census written entries	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N
The written entry in question 22 conflicts with the numeric code in question 22	Y	N	N	Y	N	N	N	Y	Y	N	N	N	N	N
The written entry in question 23 conflicts with the numeric code in question 22	*	Y	N	*	Y	N	N	*	*	Y	Y	N	N	N
The written entry in question 24 conflicts with the numeric code in question 22	*	*	Y	*	*	Y	N	*	*	*	*	Y	Y	N
The numeric code in question 22 is 459 or 437-448	Y	Y	Y	N	N	N	NA	NA	NA	NA	NA	NA	NA	NA
The numeric code in question 22 is 451	NA	NA	NA	NA	NA	NA	NA	Y	N	Y	N	Y	N	*
Actions[2]														
Treat numeric code in question 22 as additional information	X	X	X	-	-	-	X	-	X	-	X	-	X	X
Ignore the numeric code in question 22	-	-	-	X	X	X	-	X	-	X	-	X	-	-

[1] For conditions:
Y - means "yes", the condition must be true.
N - means "no", the condition must be false.
* means ignore, the condition is not relevant.
NA - means "not applicable".

[2] For actions:
X means execute, i.e., perform the action.
- means ignore, i.e., do not perform the action.

APPENDIX C

Census Rules for Coding Occupation

Note: Excerpted from U.S. Bureau of the Census, 1970 Decennial Census of Population, Procedures Manual, Volume III, Part V, Chapter A, "Industry and Occupation Coding", May 6, 1970.

After an industry code has been entered in item 33, examine items 34a, b and c. From this find the appropriate code in the **Alphabetical Index** following the instructions below:

The final determination of a correct code for a particular listing in the occupation portion of the Index is the result of the proper consideration of the occupation return (item 34a, b, c), the code of the industry return (item 33a, b, c) and sometimes the class of worker item (item 35). If a written entry cannot be coded after following the **Index** instructions, refer the entry.

a. **Coding to most specific entry.** In determining the proper code for an occupation return, consider the entries in items "a" and "b" as a combined entry. For example, if item "a" says "machine operator" and item "b" says "runs a lathe," combine the entries and code "lathe operator" not "machine operator" because it is the most specific entry. On occasion, two distinctive jobs will be described in "a" and "b"; for example, on line "a" "receptionist-typist" may appear and on line "b" "typist" will be written. In such a case code that job appearing on line "b", for the respondent has told us he considers that his main activity. Sometimes line "b" repeats the double job function given on line "a", for example "receptionist-typist" appears on line "a" and also on line "b". In such a case code the lowest number code,[1] in this case code 364 for receptionist.

If one of the codes in the comparison is a letter code, use the following numeric equivalents of the letter codes. In coding, use only the letter code, never their number equivalents.

N-142	S-473	W-801
P-305	T-602	X-903
Q-372	U-715	Y-915
R-415	V-751	Z-984

At times the **Index** lists activities along with a job title which means you must refer to Item 34b of the schedule. For example, if 34a says "porter" you will need to look at 34b for clarification. If 34b says "cleaning" or the like, it is covered in the **Index** listing of: Porter, cleaning. . . . . 902. The **Index** also has a listing for: Porter, baggage . . . . . 934, which would be used if item 34b had said "handle baggage" or a similar entry.

[1] This rule is known as the "lowest-code" rule.

b. **Additional rules for use of items 34b and 34c**

(1) When not to use item 34b. – At times the **Index** will say "any activity." In this case you will not use item b. If, for example, 34a says "secretary" and 34b says "filing and typing," you will find in looking up secretary, the **Index** gives a listing for "Secretary, any activity." For this entry, you will use only 34a and disregard the activities listed in 34b.

(2) Use of job title question (34c) – Item 34c should be used only when a code cannot be assigned by using 34a or b, for example, where both 34a and 34b are too broad or general. In such a case, code using 34c if it clarifies and/or is consistent with items 34a and 34b. If it is not consistent, use the rule of lowest number in instruction 3a.

c. **Coding of occupation from Industry.** In some cases the information found in all parts of item 34 is not enough to properly code occupation, but the needed information can be found in item 33. For example, item 33b may say "auto body repair shop" and item 34 "mechanic." In this case you can code the person as an auto body mechanic.

d. **Alphabetic Index.** Occupation titles are listed in the **Index** in several ways. These are:

(1) Occupation titles with no restrictions
Ticket writer 394
This means that if the schedule entry reads "Ticket writer" the proper code to be entered in code box 34 would be 394.

(2) Occupation titles with Industry and/or Class of Worker restrictions.
There are a number of types of restrictions. In all cases the occupation title is in the left columns and the occupation code in the right column.

(a) Title with one industry code in the center:
Salesman. 287. 705
This means that you can code your occupation 705 only when the industry has been assigned the code 287.

(b) Title in combination with range of industry codes

Compensator man . . . . . 307-318. . . . 620
If the industry code had been assigned 308,

you could code the "compensator man" 620, because code 308 falls within the range 307-318. If the industry code does not fall within this range of codes in the middle column, you cannot use the code for occupation.

(c) Title in combination with several industry codes:

Criminal investigator. . .L, M, 907, 927. . .964

In identical fashion as the industry range, here the occupation code 964 can be used only if you have assigned as the industry every entry on your schedule one of the four codes in the center.

APPENDIX D

Influence of Professional Indentification on Reporting of Postcensal Manpower Survey Occupation

The table in this appendix was created in the hopes of indicating the influence of professional identification in 1972 on the PMS response when it conflicts with the census response. The universe for the table is restricted, therefore, to cases with conflicting response differences.

ANALYSIS

In the majority (about 61 percent) of the conflicting responses, the respondent reported a professional identification[1] in 1972 in the PMS that was the same as the 1970 PMS occupation. In only about 16 percent of the cases did the respondent report a professional identification that agreed with the 1970 census occupation. In nearly 18 percent of the conflicting-response cases, the person gave a professional identification that did not match his or her 1970 census occupation or his or her 1970 PMS occupation. The 1972 professional identification was not reported in about 6 percent of the cases.

The percentage of conflicting-response cases for which the professional identification agreed with the 1970 PMS occupation differs very little among the various occupational groups. The percentage ranges from about 59 percent for life scientists to about 63 percent for mathematical specialists. There is more variation (about 8 percent for social scientists to about 27 percent for life scientists) among the occupational groups for persons whose professional identification matches their 1970 census occupation.

[1] Item 41 of the PMS questionnaire asked the respondent to complete the following statement by inserting a code and a description from List C: "Based on my total education and experience, I regard myself professionally as a (an) . . ."

Table D. Conflicting Responses, by Agreement Between 1972 PMS Professional Identification and Detailed 1970 PMS and Detailed 1970 Census Occupation, by Major 1970 Census Occupational Groups

Major 1970 census occupational group	Total	Professional identification in 1972				1972 Professional identification not reported
		Same as 1970 PMS occupation	Different from 1970 PMS occupation			
			Total	Same as 1970 census occupation	Different from 1970 census occupation	
ALL OCCUPATIONS						
Number	290	176	97	46	51	17
Percent	100.0	60.7	33.4	15.9	17.6	5.9
OPERATIONS AND COMPUTER SPECIALISTS						
Number	67	40	22	8	14	5
Percent	100.0	59.7	32.8	11.9	20.9	7.5
ENGINEERS						
Number	67	41	23	12	11	3
Percent	100.0	61.2	34.3	17.9	16.4	4.5
MATHEMATICAL SPECIALISTS						
Number	38	24	11	4	7	3
Percent	100.0	63.2	28.9	10.5	18.4	7.9
LIFE SCIENTISTS						
Number	34	20	12	9	3	2
Percent	100.0	58.8	35.3	26.5	8.8	5.9
PHYSICAL SCIENTISTS						
Number	61	38	21	12	9	2
Percent	100.0	62.3	34.4	19.7	14.8	3.3
SOCIAL SCIENTISTS						
Number	25	15	9	2	7	1
Percent	100.0	60.0	36.0	8.0	28.0	4.0

Note: Agreement between 1972 PMS professional identification and PMS and census occupations was determined at the detailed level of occupational classification.

APPENDIX E

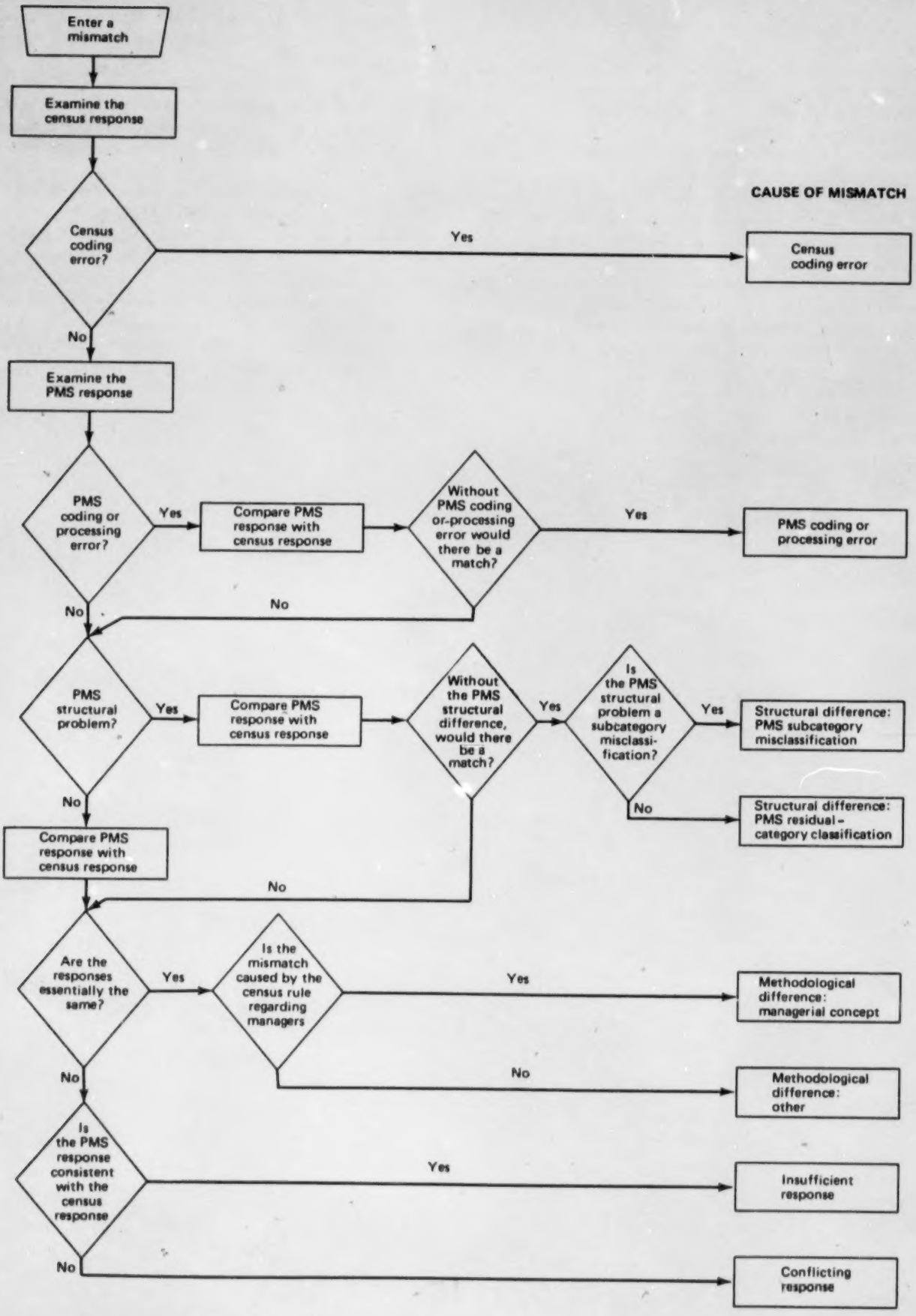
Reconciliation Process

The classification of the causes of mismatches is described in the body of the report. The process by which each mismatch was placed in one of these categories is described in this appendix. Throughout this process, a hierarchy of causes was established; the lower the category appears in the classification scheme shown in example 2 (see page 8), the higher it is in the hierarchy (for example, "methodological differences" are higher than "PMS coding errors"). A search was made for that cause in whose absence the PMS and census occupational categories would have matched or corresponded. In most cases, if two or more reasons for the mismatch were identified, the highest one in the hierarchy was considered to have caused the mismatch.

The first step in the process was the independent examination of both the census response and the PMS response. The basis of the code assigned to the census response was examined, and, for cases in which the assignment depended upon an industry or class-of-worker designation, the bases of these codes were also examined. If a census coding error was discovered, this error was considered to be the sole cause of the mismatch, and no attempt was made to locate another cause. This procedure was the only exception to the rule that the highest of two or more reasons was chosen as the only reason for the difference. If the census coding was correct, the PMS response was examined for coding and processing errors.

After an independent verification of each report was made, the PMS response was compared with the census response. Cases with the same or essentially the same responses were separated from those with different responses. The former cases were then closely examined for structural or methodological differences.

Finally, cases with different responses were investigated. The consistent responses were separated from the inconsistent or conflicting ones. The consistent responses were examined for evidence of the various kinds of insufficient responses; for the conflicting responses, an attempt was made to find the reasons for the conflicts. Discovering the underlying reasons for the conflicting responses put the investigator into an area of speculation, and such factors as the reference periods, the company names and locations, and the person's professional identification (see appendix D) for certain jobs were examined. The chart in this appendix is a flowchart of the entire reconciliation process.


Enter a mismatch
Examine the census response
Census coding error?
Yes
CAUSE OF MISMATCH
Census coding error
No
Examine the PMS response
PMS coding or processing error?
Yes
Compare PMS response with census response
Without PMS coding or-processing error would there be a match?
Yes
PMS coding or processing error
No
No
PMS structural problem?
Yes
Compare PMS response with census response
Without the PMS structural difference, would there be a match?
Yes
Is the PMS structural problem a subcategory misclassi-fication?
Yes
Structural difference: PMS subcategory misclassification
No
Structural difference: PMS residual – category classification
No
Compare PMS response with census response
No
Are the responses essentially the same?
Yes
Is the mismatch caused by the census rule regarding managers
Yes
Methodological difference: managerial concept
No
Methodological difference: other
No
Is the PMS response consistent with the census response
Yes
Insufficient response
No
Conflicting response

APPENDIX F

Sample Design, Estimation Procedure, and Reliability of the Estimates

SAMPLE DESIGN AND ESTIMATION PROCEDURE

The sample of occupational classification differences (mismatches) was a stratified, systematic sample of mismatches selected from a universe of mismatches consisting of all scientific and technical occupational classification differences between the 1970 census occupational classification and the PMS occupational classification. The universe was stratified by major occupational groups and by level of mismatch, forming a total of 12 stratums. The sample size in each stratum was determined so as to produce a coefficient of variation of at most 12.5 percent.

The estimates produced from the sample of mismatches are attributes in the form of proportions. The standard errors are estimated assuming the systematic sampling procedure is equivalent to a simple random sample of mismatches.

RELIABILITY OF THE ESTIMATES

The sample used for this match study is only one of a large number of possible samples of the same size that could have been selected using the same sample design, sample selection, and measurement procedures. Estimates derived from these samples would differ from each other.

The standard error is a measure of the variation among the estimates from all possible samples and is, therefore, a measure of the precision with which an estimate from a particular sample approximates the average result of all possible samples.

The estimate and its associated standard error may be used to construct a confidence interval; that is, if all possible samples were selected, each of these surveyed under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average value of all possible samples. The average value of all possible samples may or may not be contained in any particular computed interval. But for a a particular sample, one can say with specified confidence that the average of all possible samples is included in the constructed interval. Similarly, the chances are about two out of three that the survey estimate will differ from the average result of all possible samples by less than one standard error, and 99 out of 100 that the survey estimate will differ from the average result by less than 2½ times the standard error.

★★★

working papers

No. 1. Raw Materials in the United States Economy: 1900-52 (Preliminary)
No. 2. The Role of the 1954 Census of Manufactures in Overcoming Problems of Industry Data
No. 3. Tract Data Compared for a 25-Percent Sample and a Complete Census
No. 4. Sampling in the 1950 Census of Population and Housing
No. 5. Occupational Trends in the United States: 1900 to 1950
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